MICROCOPY RESOLUTION TEST CHART

NPS-012-86-003

① FY 1985

AD–A174 795

A SUMMARY OF THE NAVAL POSTGRADUATE SCHOOL RESEARCH PROGRAM

REPORT FOR THE PERIOD
OCT 1984 TO SEPT 1985

DTIC
ELECTE
DEC 5 1986
S   D
B

NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

057

86 12 03 057

NAVAL POSTGRADUATE SCHOOL
Monterey, California
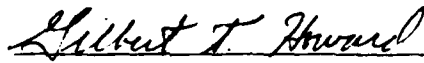
Rear Admiral R. H. Shumaker   David A. Schrady
Superintendent   Provost

The work reported herein was supported by various Department of
Defense activities and federal government agencies.
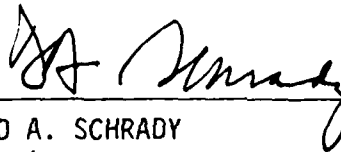
Reproduction of all or part of this report is authorized.

Prepared by:

Gilbert T. Howard

GILBERT T. HOWARD
Director of Research Administration

Released by:

David A. Schrady

DAVID A. SCHRADY
Provost

ADA 174795

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	Unlimited distribution; approved for public release.

4. PERFORMING ORGANIZATION REPORT NUMBER(S) NPS-012-86-003	5. MONITORING ORGANIZATION REPORT NUMBER(S) NPS-012-86-003

6a. NAME OF PERFORMING ORGANIZATION Naval Postgraduate School	6b OFFICE SYMBOL (If applicable) RAO	7a. NAME OF MONITORING ORGANIZATION

6c. ADDRESS (City, State, and ZIP Code) Monterey, CA 93943	7b. ADDRESS (City, State, and ZIP Code)

8a. NAME OF FUNDING/SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER

8c. ADDRESS (City, State, and ZIP Code)	10 SOURCE OF FUNDING NUMBERS			
	PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.

11 TITLE (Include Security Classification)

A SUMMARY OF THE NAVAL POSTGRADUATE SCHOOL RESEARCH PROGRAM

12. PERSONAL AUTHOR(S)
Faculty of the Naval Postgraduate School

13a. TYPE OF REPORT SUMMARY	13b. TIME COVERED FROM 10/1/84 TO 9/30/85	14. DATE OF REPORT (Year, Month, Day) 1986 September 30	15. PAGE COUNT 398

16 SUPPLEMENTARY NOTATION

17 COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Research Program

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report contains 227 summaries of research projects which were carried out under funding to the Naval Postgraduate School Research Program. This research was conducted under the areas of Computer Science, Mathematics, Administrative Sciences, Operations Research, National Security Affairs, Physics, Electrical and Computer Engineering, Meteorology, Aeronautics, Oceanography, and Mechanical Engineering. The table of contents identifies specific research topics.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a NAME OF RESPONSIBLE INDIVIDUAL DR. G.T. HOWARD	22b TELEPHONE (Include Area Code) (408) 646-2098	22c. OFFICE SYMBOL RAO/012

DD FORM 1473, 84 MAR   83 APR edition may be used until exhausted.   SECURITY CLASSIFICATION OF THIS PAGE
All other editions are obsolete.

INTRODUCTION

Research activities at the Naval Postgraduate School during the fiscal year 1985 are abstracted in this summary volume. These results are due to the efforts of faculty investigators with, in most cases, student contributions through activity leading to a thesis in pursuit of an advanced degree.

The importance of research at the Naval Postgraduate School is recognized in the mission statement:

" .... to encourage a program of research in order to sustain academic excellence."

Research at a graduate institution such as NPS provides intellectual stimulation to faculty, enhances the instructional activities, and contributes directly to the solution of real Navy as other DoD problems. Sponsor benefits include augmentation of research efforts with student activity and exposure of students to areas of current concern.

The Naval Postgraduate School provides a unique interface between academic institutions and the U.S. Navy. The research projects undertaken are, in general, clearly related to Navy and DoD interests. A substantially larger fraction of the R&D effort at NPS is in the exploratory development category than would be found in most universities. This is a result of student and faculty interests and an institutional requirement to educate officers in areas of direct relevance to the Navy and to support the institutional programs with relevant research.

Additional information about research activities at NPS can be obtained from the Director of Research Administration, Code 012, Naval Postgraduate School, Monterey, CA 93943.

Pages 325, 329, and 330 were intentionally left blank
Per Ms. Rachelle Park, NPS/Code RAO-012

RE: Classified References, Distribution Unlimited
No change per Ms. Rachelle Park, NPS/Code RAO-012

Accession For	
NTIS GRA&I	✔
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

iii

NAVAL POSTGRADUATE SCHOOL
Monterey, California

PROCEDURES FOR REQUESTING NAVAL POSTGRADUATE SCHOOL
TECHNICAL REPORTS AND THESES

Copies of publications with unlimited distribution may be
obtained from either of the following agencies depending
upon the particular circumstances:

Individuals affiliated with a research and development
activity within the U.S. Government or its associated
contractors, subcontractors, or grantees, under current
U.S. Government contract, order from:

DEFENSE TECHNICAL INFORMATION CENTER
Cameron Station
Alexandria, VA 22304-6145

Organizations or individuals who do not fall within the
above categories may order from:

NATIONAL TECHNICAL INFORMATION SERVICE
U.S. Department of Commerce
Springfield, VA 22161

A given document may be obtained by submitting a biblio-
graphic citation including: (1) author, (2) title,
(3) publication date, and (4) the Naval Postgraduate
School Report Number or reference to the document as
a Naval Postgraduate School thesis.

General inquiries concerning faculty and student research
at the Naval Postgraduate School should be addressed to:

Superintendent
Naval Postgraduate School
(Attn: Research Administration Office/Code 012)
Monterey, CA 93943

TABLE OF CONTENTS

x

DEPARTMENT

OF

COMPUTER SCIENCE

DEPARTMENT OF COMPUTER SCIENCE

The research in the Computer Science Department consists of student thesis work and faculty research in the core areas of computer science and in the novel use of computer systems for Navy high-tech applications. The Departmental research efforts have allowed the development of extensive research facilities that feature microcomputers, minicomputers, computer graphic devices, image and signal processing equipment, workstations, and database computers.

COMPUTER SOFTWARE DESIGN

Professor Gordon Bradley and his students have been performing research in cognitive sciences and reusable software as new directions. Their objective is to apply cognitive sciences and software engineering principles to software, particularly the reusable programs, to produce better designs.

DATABASE COMPUTERS

Professor David K. Hsiao, S.A. Demurjian and their thesis students are doing research in the use of database computers to meet the performance requirements of fast response with huge amount of data to be analyzed. Their investigations lead them to the parallel architecture of multi-backend computers with sophisticated software and microprocessor-based hardware for this architecture.

MULTI-LINGUAL DATABASE SYSTEM

Professor David K. Hsiao, S.A. Demurjian and their thesis students studied the problem of supporting multiple database models in a single database management system. In addition, they are examining the issue of how to use the multi-lingual software to support many database languages. A prototype to implement their approaches is in progress.

MULTI-MEDIA DATABASE SYSTEM

Professor C. Thomas Wu investigated the various aspects of providing an information system to support multi-media databases. His research covers issues in data model, user interface, storage structure and parallel processing.

MULTI-MICROCOMPUTER ARCHITECTURE

Professor Uno R. Kodres and Professors R. Panholzer, M.L. Cotton, and S.W. Therrien of ECE, together with their students explored the use of

multi-microcomputers to control the SPY-1A radar. The operating system for multiple computers developed earlier has been extended to operate in a distributed environment, where clusters of microcomputers are connected via Ethernet to permit physical distribution. Application programs written for execution in this operating system need not specify on which computer the processes are to be done. In addition, Professor Kodres and his thesis students investigated the use of single-chip computers to build a larger multi-computer network. Their long-term goal is to create a reliable computer system using the single-chip computers.

SOFTWARE PORTABILITY

Professor Dan. L. Davis and his thesis students continued their pursuit in search of solutions to the problem of portable software based on the approach of describing computing resources abstractly. Using their earlier results where the concept of abstract data type is used to build a framework for describing resources, they designed and implemented a processor which allows its programs written for this processor to have the same portability as if these programs have been written in high-level languages.

SYSTEM ARCHITECTURE FOR REAL-TIME GRAPHICS GENERATION

Professor M.J. Zyda and his students have been investigating the application of VLSI technology to graphics systems to support real-time display generation. Their investigations included the proposal of algorithms and system architecture to generate contour surfaces, the modelling of such sustems, and the implementation aspects of their proposals in VLSI technology. Some of their works have been implemented for demonstration and use in the Silicon Graphics, Inc., IRIS graphics workstations.

ULTRA-HIGH-LEVEL PROGRAMMING

Professor Bruce J. MacLennan and his thesis students performed research on programming with the goal of developing a method, based on combining the concepts of object oriented and functional programming, such that users of this method can increase their productivity by an order of magnitude. They have designed a system and implemented a number of interpreters for their language and other programming environment tools to allow them to evaluate the effectiveness of their proposals.

Title:	Portable Software, Formal Semantics, and Limited Resource Systems
Investigator:	D. Davis, Associate Professor of Computer Science
Sponsor:	NPS Foundation Research Program
Objective:	To develop a methodology for describing computing resources abstractly, that is, independently of their implementation, as a framework for creating portable reusable computing resources.

| Summary: | This work is a continuation of work begun in the previous year. Last year, a theoretical framework was developed for describing computing resources abstractly, using techniques from the theory of abstract data types. During the past year, this framework has been used to guide the design and implementation of a number of abstract components of a typical computing system, as a test of the practical feasibility of the methodology we have developed. Specifically we designed and implemented an abstract processor. The unique characteristic of this processor's design is that its functional features, that is, "what" features it provides, are described independently of "how" these features are realized. In fact the first realization of this processor was written in software. The significance of this characteristic is that programs written to run on this abstract processor have the same portability properties as programs in a high level language. The only difference in realizations of the abstract processor is a difference in efficiency, there can be no difference in meaning or functionality. We feel this work is a forward step in solving the problem of portability problem, since it provides a means for defining and implementing resources in a pure form. Currently, computing resources are designed and implemented as a complex mixture of "what" we wish to have abstractly with "how" we can realize it. |

| Publications: | D. Davis, "A Formal Method for Specifying Computer Resources in an Implementation Independent Manner," NPS Technical Report, NPS52-84-022, December 1984.

D. Davis and J. Yurchak, "The Specification, Design and Implementation of an Abstract Processor," forthcoming. |

5

Conference Presentation:	D. Davis, "Resource Abstration and Validation," Verkshop III Conference on Verification, Pajaro Dunes, February 1985.
Theses Directed:	J. M. Yurchak, "The Formal Specification of an Abstract Machine: Design and Implementation," <u>Master's Thesis</u>, December 1984.

R. Griffin, "An Algorithm to Test for Confluence in a System of Left to Right Rewrite Rules," <u>Master's Thesis</u>, December 1984.

N. Lilly, "An Algebraic Specification Language and A Syntax Directed Editor," <u>Master's Thesis</u>, December 1984.

J. E. Hunter, "The Formal Specification of a Visual Display Device: Design and Implementation," <u>Master's Thesis</u>, June 1985.

U. Ozkan, "A Survey of Properties of Relations Which Have the Confluence Property," <u>Master's Thesis</u>, June 1985.

Title:	Multi-Lingual Database System Architecture
Investigator:	D. K. Hsiao, Professor of Computer Science and S. A. Demurjian, Adjunct Research Instructor of Computer Science
Sponsor:	Office of Naval Research
Objective:	Unlike the conventional database system which supports only a single data model and a model-based data language, the multi-lingual database system is aimed to support many data models and model-based data languages. Consequently, such a system allows wider and more diverse database applications and database sharing.
Summary:	Our new research effort has reached its midpoint where the multi-lingual database system (MLDS) can support the attribute-based model and its data language ABDL, the hierarchical data model and its DL/1, and the relational data model and its SQL.
Publications:	S. A. Demurjian and D. K. Hsiao, "New Directions in Database-Systems Research and Development", Proceedings of the New Directions in Computing Conference, IEEE Computer Society, August 1985.
Conference Presentations:	D. K. Hsiao, "Multi-Lingual Database System Architecture," ONR and ONT Conference on Information Systems, NOSC, San Diego, CA, April 17 and 18, 1985. D. K. Hsiao, "Multi-Lingual and Multi-Backend Database Computers," Database '85 Colloqium, Naval Security Group and NOSC, San Diego, CA, June 4, 5, and 6, 1985.
Theses Directed:	T. B. Benson and G. L. Wentz, "Design and Implementation of a Hierarchical Interface for the Multi-Lingual Database System," Master's Thesis, June 1985. G. R. Kloepping and J. F. Mack, "Design and Implementation of a Relational Interface for the Multi-Lingual Database System," Master's Thesis, June 1985.
Patent Application:	(It is the expressed view of the investigators that the result of the research is for public use and that no patent application will be filed for).

Title: The Role of Modern Database Systems in Support of
                  Software Engineering Environments

Investigators: D. K. Hsiao, Professor of Computer Science and
                  S. A. Demurjian, Adjunct Research Instructor of
                  Computer Science

Sponsor: DOD STARS Program Office

Objective: To examine the use of multi-lingual software for
                  supporting many database languages in a given soft-
                  ware engineering environment, the employment of
                  multi-backend architecture for performance gains
                  and capacity growth in prototyping software and
                  managing tools, and the possibility of making the
                  multi-lingual and multi-backend database system
                  portable to every software engineering environment.

Summary: As a new effort, we have achieved a number of mile-
                  stones. We have acquired a number of modern work-
                  stations for the multi-backend software. We have
                  developed a methodology to generate benchmarks for
                  the multi-backend computer. We have examined the
                  issues of interfacing the multi-lingual software
                  with the multi-backend computer.

Publications: S. A. Demurjian, D. K. Hsiao, D. S. Kerr, J. Menon,
                  P. Strawser, R. C. Tekampe, and R. J. Watson,
                  "Performance Evaluation of a Database System in a
                  Multiple Backend Configurations," Proceeding of the
                  Fourth International Workshop on Database Machines,
                  Grand Bahama Island:MCC, March 1985.

                  S. A. Demurjian, D. K. Hsiao and J. R. Vincent,
                  "A Benchmarking Methodology for the Centralized-
                  Database Computer with Expandable and Parallel Data-
                  base Processors and Stores," Naval Postgraduate
                  School Technical Report, NPS52-85-011, August 1985

                  S. A. Demurjian, D. K. Hsiao and J. Menon, "A Multi-
                  Backend Database System for Performance Gains and
                  Capacity Growth and Hardware Upgrade,"Naval Post-
                  graduate School Technical Report, NPS52-85-002,
                  February 1985.

                  S. A. Demurjian, D. K. Hsiao and P. R. Strawser,
                  "Design Analysis and Performance Evaluation Method-
                  ologies for Database Computers," Naval Postgraduate
                  School Technical Report, NPS52-85-009, June 1985.

8

S. A. Demurjian, D. K. Hsiao and R. G. Marshall, "The Architectural Requirements and Integration Analysis of a Database Server for Office Automation," Naval Postgraduate School Technical Report, NPS52-85-008, May 1985.

S. A. Demurjian, D. K. Hsiao, D. S. Kerr, R. C. Tekampe and R. J. Watson, "Performance Measurement Methodologies for Database Systems," Naval Postgraduate School Technical Report, NPS52-84-023, December 1984.

Conference Presentation:

D. K. Hsiao, "Performance Gains and Capacity Growth of the Multi-Backend Database Computer," The 4th International Conference on Database Machines, Great Bahama Island, March 6, 7 and 8, 1985.

D. K. Hsiao, "Research in Database Systems" Computer Science Colloguium, University of California, Berkeley, CA, April 24, 1985.

D. K. Hsiao, "Laboratory for Database Systems Research," The NAVDAC Workshop on Database Machines, Monterey, CA, May 30-31, 1985.

D. K. Hsiao, "Database Computers in Office Automation Environment," NALTOACS Conference on Office Information Systems, San Diego, CA, May 15-16, 1985.

D. K. Hsiao, "Database Machines," Federal Computer Conference, Washington, D.C., Sept. 10, 1985.

Theses Directed:

H. L. Tung, "Design and Analysis of a Database Operation, Retrieve-Common, for the Multi-Backend Database System (MBDS)," Master's Thesis, June 1985.

J. R. Vincent, "A Benchmarking Methodology for Multi-Backend Database Systems," Master's Thesis, June 1985.

Patent Application:

(It is the expressed view of the investigators that the result of the research is for public use and that no patent application will be filed for.)

9

Title: Emulation of a Multi-Microcomputer Architecture
                          for the SPY-1A Control Computer

Investigators: U. R. Kodres, Professor of Computer Science,
                          R. Panholzer, Associate Professor of Electrical
                          and Computer Engineering, M. L. Cotton, Associate
                          Professor of Electrical and Computer Engineering,
                          C. W. Therrien, Associate Professor of Electrical
                          and Computer Engineering.

Sponsor: Naval Sea Systems Command

Objective: To explore the use of large scale integrated cir-
                          cuit technology in order to control the SPY-1A
                          radar. A multicomputer emulation of the functions
                          of the SPY-1A control computer will be carried
                          out, in order to determine the feasibility of such
                          an approach.

Summary: A major goal of the ongoing emulation project was
                          reached during the past year. The operating sys-
                          tem for multiple processor computer cluster,
                          MCORTEX, was extended to permit the operation of
                          of a distributed multiple cluster system. The
                          system of clusters, each of which typically con-
                          tains eight processors which share information by
                          storing it in shared memory, is interconnected by
                          a high speed (10 megabits/sec) Ethernet interface.
                          This architecture permits physical distribution of
                          systems components for reliability and survivabili-
                          ty. The extended MCORTEX operating system, RTC*,
                          permits synchronization and data sharing across
                          the cluster boundaries in the same simple way that
                          this is done within the cluster. This allows
                          applications programs to be written so that the
                          applications programmer need not know on which
                          computer and in which cluster his processes are
                          executed, or where the data resides during pro-
                          cessing.

                          The lead system's designer determines how pro-
                          cesses are partitioned among the processors so
                          that execution time is evenly balanced among pro-
                          cessors and data sharing is efficiently carried out
                          either in shared memory or using communications on
                          the network.

A multiple sensor distributed decision algorithm
was developed and analyzed. This algorithm was
implemented in a two-node network of multiple micro-
processors. Issues of process synchronization for
this type of application were addressed.

Theses Directed: D. J. Brewer,"A Real-Time Executive for Multiple
Computer Clusters," Master's Thesis, December 1984.

Z. Selcuk, "Implementation of a Serial Communica-
tions Process for a Fault Tolerant, Real Time,
Multitransputer Operating System," Master's Thesis,
December, 1984.

B. Evin, "Implementation of a Serial Delay Inser-
tion Type Loop Communication for a Real Time
Multitransputer System," Master's Thesis, June 1985.

Title: Systems Simulation/Emulation On A Multiple Transputer System

Investigator: U. R. Kodres, Professor of Computer Science

Sponsor: Strategic Systems Project Office, LCDR L. Sentman

Objective: The project explores the use of a single chip computer, the so-called transputer. As a component of a larger multicomputer network. The software and hardware design to make such a network a reliable as well as fault tolerant system is the long term objective of this project.

Summary: A major accomplishment of the project was to simulate two forms of a network of single chip computers on the VAX 11/780 system. One network consists of a four by four array of processors interconnected to the nearest neighbors. The other form consist of loops of processors for use as interface processors connecting clusters of computers. A hardware system, consisting of two transputers which can be interconnected to each other and to the VAX 11/780 systems for program development and downloading, was also installed in the laboratory. This system allows performance studies to compare data sharing in two forms: shared memories or point to point data communications between transputers.

Theses Directed: Z. Selcuk, "Implementation of a Serial Communications Process for a Fault Tolerant, Real Time, Multitransputer Operating System," Master's Thesis, December, 1984.

B. Evin, "Implementation of a Serial Delay Insertion Type Loop Communication for Real Time Multitransputer System," Master's Thesis, June 1985.

12

Title: Combining Object-Oriented and Functional Programming

Investigator: B. J. MacLennan, Associate Professor of Computer Science

Sponsor: Office of Naval Research

Objective: Object-oriented programming and value-oriented programming are two recently developed programming paradigms that have the promise of being much more effective than traditional software development methodologies. This project will investigate the foundations of object-oriented and value-oriented programming, and explore means by which the advantages of each can be combined into a unified methodology.

Summary: This past year progress was made in a number of areas pertaining to both the theoretical foundations and practical problems of combining object-oriented and functional programming. Theoretical results include further insights into the relationships among the function-oriented, relation-oriented, logic-oriented and object-oriented programming paradigms, and also mathematical techniques for manipulating programs in these paradigms. Practical results include the development of a number of interpreters and their use in assessing the practicality of the various paradigms.

In December 1984 Heinz M. McArthur completed an interpreter for a prototype Dyad system. This interpreter handles almost the entire Φ language and a large subset of the A language. This is a very high quality system, which is suitable for implementation studies of moderate size. It is implemented in C for efficiency, and interfaces smoothly with the Berkeley Unix system for utilities and conveniences.

In December 1984 Ralph Steen completed a prototype interpreter for a subset of the A language known as ELC. This interpreter is coded in Pascal and runs on Berkeley Unix. It was intended for use in implementation and performance studies and will not be a component of the final Dyad system.

Functional programming systems can be profitably viewed as a special case of tree transformation systems. In conjunction with a study of the applicability of tree transformation systems to value-oriented programming, several tree transformation systems have

13

been developed. One of these, completed by Mohamed Chok in December 1984, incorporates a syntax-directed editor that permits the use of natural language words and phrases.

We have described four alternate syntactic forms for ⋏ . These include a predicate logic style (which is used in the AcArthur interpreter), two pseudonatural styles and two-dimensional style based on the idea of forms. Grammars have been developed for each of these styles, and several programs have been coded in all of the styles, thus permitting comparison. The implementation of a dialect of one of these styles is described next.

Robert Ufford has developed a pseudonatural language interface for the ⋏ system. This system permits a rule such as this:

*Command (in), *CurrentNode (E), Left(X,E)
⟶ CurrentNode(X).
to be written in the more readable form:

If given that "in" is the command,
given that an expression is the current-node,
and a node is the left-argument of the expression
then the node is the current-node.

The translator is written in Pascal and generates rules in a format acceptable to the McArthur interpreter. To evaluate the system Ufford has translated a number of ⋏ programs into his pseudonatural notation, including the prototype programming environment described in one of our reports.

Jim Brown and Steve Mitton have completed a LISP-based implementation of the relational programming language described in their thesis. This language attempts to extend many of the advantages of functional programming to relations. Thus it promises a higher level programming ability, in addition to simpler algebraic derivation and manipulation of programs.

One aspect of this project is to study the use of to program some of the tools that constitute a programming environment. These tools include an interpreter, unparser, syntax directed editor, command interpreter, debugger and code generator. The environment supports programming in a small applicative

14

language. The results of this study, including the
programming environment, will be published in a ser-
ies of reports, the first of which is completed and
the second of which is in progress.

In an effort to explore the power of functional pro-
gramming and to get new insights into the constructs
useful in functional programming, we have used func-
tional programming methods for a constructivist foun-
ation of real analysis based on the pure lambda cal-
culus. This is described in a report.

Preliminary results have been obtained in the devel-
opment of a mathematical calculus of functional and
relational programming. The goal of this calculus
is to facilitate the derivation and transformation
of programs. It will be described in future reports.

<table>
<tr><td>Publications:</td><td>B. J. MacLennan, "Computable Real Analysis," NPS Tech-
nical Report, NPS52-84-024, December 1984.</td></tr>
</table>

B. J. MacLennan, "The Four Forms of ψ : Alternate Syn-
tactic Forms for an Object-Oriented Language," NPS
Technical Report, NPS52-84-026, December 1984.

B. J. MacLennan, "A Simple Software Environment Based
on Objects and Relations," Proc. of ACM SIGPLAN 85
Conf. on Language Issues in Prog. Environments and
NPS Technical Report, NPS52-85-005, April 1985.

B. J. MacLennan, "Experience with ψ: Implementation
of a Prototype Programming Environment, Part I, NPS
Technical Report, NPS52-85-006, May 1985.

B. J. MacLennan, "Experience with ψ : Implementation
of a Prototype Programming Environment, Part II," NPS
Technical Report, forthcoming.

B. J. MacLennan, "A Calculus of Functional Differences,
Part I: Fixed Differences, NPS Technical Report,
forthcoming.

B. J. MacLennan, "A Calculus of Functional Differences,
Part II: Variable Differences," NPS Technical Report,
forthcoming.

B. J. MacLennan, "Three Relational Program," NPS Tech-
nical Report, forthcoming.

Conference Presentations:	B. J. MacLennan, "*On the Validation of Computer Science Theories,*" Second Symposium on Empirical Foundations of Information and Software Science, Atlanta, Georgia, October 3, 4, and 5, 1984. B. J. MacLennan, "A Simple Software Environment Based on Objects and Relations," ACM SIGPLAN '85 Conference on Language Issues in Programming Environments, Seattle, Washington, June 25, 26, 27 and 28, 1985.
Theses Directed:	H. M. McArthur, "Design and Implementation of an Object-Oriented, Production-Rule Interpreter," Master's Thesis, December 1984. R. Steen, "An Interpreter for the Functional Programming Language ELC," Master's Thesis, December, 1984. M. B. Chok, "Investigation and Implementation of a Tree Transformation System for User Friendly Programming," Master's Thesis, December, 1984 J. R. Brown and S. G. Mitton, "Relational Programming: Design and Implementation of a Prototype Interpreter," Master's Thesis, June 1985. R. P. Ufford, "The Design and Analysis of a Stylized Natural Grammar for an Object-Oriented Language (Omega)," Master's Thesis, June 1985.

Title:	Synthesis of an Information Processing Support System for Advanced Applications
Investigator:	C. T. Wu, Associate Professor of Computer Science
Sponsor:	None
Objective:	To design, analyze, and develop a true information system that is capable of handling multimedia data. Some of the specific objectives include (a) design of a new information modelling technique, (b) investigation of the implementation issues such as user interface, storage structure, parallel processing, etc., and (c) exploration of application areas such as integrated design and manufacturing, office automation, industrial/experimental robotics, etc.

Summary:	Characteristics that a true information system must possess were identified. Preliminary analysis of currently available information modelling techniques was completed. User interface, one of the implementation issues, was investigated and our preliminary conclusion is to adopt a graphical interface for the first prototype system. Design of a new information modelling technique was partially complete and the resulting modelling technique was analyzed by applying it to the engineering database applications.

Publications:	C. T. Wu, "A New Graphical User Interface for Accessing a Database," Proceedings of Computer Graphics Tokyo '86 Conference, forthcoming. C. T. Wu, and W. A. Burkhard, "Associate Searching in Multiple Storage Units," ACM Transactions on Database Systems, forthcoming. C. T. Wu, "Data Organization Method for the Parallel Execution of Relational Operations," Proceedings of International Conference on Foundations of Data Organization, Kyoto, Japan, May 1985. C. T. Wu, and W. A. Burkhard, "Concurrency in Linear and Interpolation Hashing," Proceedings of the 19th Annual Conference on Information Sciences and Systems, The John Hopkins University, March 1985.

17

Title: The Effects of Real-Time Display Generation on the
                      Architecture of Graphics Display Systems

Investigator: M. J. Zyda, Assistant Professor of Computer Science

Sponsor: NPS Foundation Research Program

Objective: The effects of special purpose VLSI architectures
                      on the design of the graphics display system will
                      be evaluated, with special attention to data input/
                      output rates human interaction, and currently
                      available graphics display system functionality.
                      Several graphics algorithms that have the potential
                      for VLSI implementation will be identified and
                      studied, with the goal being a characterization of
                      the changes necessary in the architecture of the
                      graphics display system required by VLSI based,
                      real-time display generators.

Summary: The research quarters covered by this proposal are
                      1 January 1985 to 31 March 1985, and 1 July 1985 to
                      30 September 1985. The following work has been
                      carried out:

                      The first objective of the study was to examine the
                      proposed architecture of one real-time display gen-
                      erator, the contour surface display generator
                      (Zyda, 1984a). Part of this objective has been car-
                      ried out in the form of four technical memoranda
                      (Zyda,1984b), (Zyda,1985a), Walker,1985a), and
                      (Walker,1985b). The first of these memoranda ex-
                      amined the feasibility of producing a real-time con-
                      tour surface display generator. The second, third
                      and fourth memoranda were studies of the architec-
                      ture of the contour surface display generator, and
                      its intended application. Part of these studies
                      was the development of a modeling methodology for
                      evaluating the physical parameters inherent to both
                      the application, and the architecture.

                      The second objective of the study was to examine
                      the input and output parameters obtained from the
                      system model in order to determine exactly how that
                      display generator can be interfaced to a graphics
                      display system. This study was carried out in
                      (Walker,1985a) and (Walker,1985b).

                      The third objective of the study was the identifica-
                      tion of other graphics algorithms with the potential

for implementation in VLSI. This work has begun
through the efforts of several current thesis stu-
dents (see list below). The studies being carried
out are cursory examinations of these algorithms
for their distributability among multiple processors.
Part of these studies will be an attempt to determine
if the changes proposed for the graphics system for
the contour surface display generator are applicable
to other real-time display generators.

Publications: M. J. Zyda, "Workstation Graphics Capabilities for
the 1990's and Beyond," NPS Technical Report, NPS52-
85-012, September 1985

R. A. Walker and M. J. Zyda, "A Systems Architecture
for Real-Time Contour Surface Display Generation,"
NPS Technical Report, NPS52-85-012, August 1985.

R. A. Walker and M. J. Zyda, "An Integrated Systems
Architecture for Real-Time Contour Surface Display
Generation," NPS Technical Report, NPS52-85-010,
August 1985.

M. J. Zyda, "The Use of VLSI Technology for the Real-
Time Generation of Graphics Displays: A Proposal,"
NPS Technical Report, NPS52-85-002, March 1985.

M. J. Zyda, "The Feasibility of a Multiprocessor for
Real-Time Contour Surface Display Generation," NPS
Technical Report, NPS52-84-025, December 1984.

M. J. Zyda, Algorithm Directed Architectures for Real-
Time Surface Display Generation, D. Sc. Dissertation,
1984.

Conference   M. J. Zyda, "Engineering Workstations: Graphics Cap-
Presentation: abilities for the 1990's and Beyond," Engineering
Workstations Conference, Institute for Graphic Com-
munication,February 3, 4, and 5, 1985.

M. J. Zyda, "The Use of VLSI Technology for the Real-
Time Generation of Graphics Display," Naval Air-Weap-
onry Signal Processing Research Workshop, December
13 and 14, 1984.

Theses Directed: M. Sahintepe, "A Graph Theoretic Algorithm for Con-
tour Surface Display Generation," Master's Thesis,
June 1985.

R. A. Walker, "An Integrated Systems Architecture for Real-Time Contour Surface Display Generation," Master's Thesis, June 1985.

M. E. Gaddis, "The Fractal Geometry of Nature: Its Mathematical Basis and Application to Computer Graphics," Master's Thesis, December 1985.

K. Coomes, "Ray Tracing Algorithms in Computer Graphics Applications: Comparisons and Implementations," Master's Thesis, March 1986.

P. Hogan, "Surface Construction via the Triangulation of Contour Slices," Master's Thesis, December 1985.

S. Mungsing, "A Software Implementation of an Interactive System for Three-Dimensional Modeling and Layout," Master's Thesis, March 1986.

A. Jones, "Surface Construction via the Triangulation of Contour Slices: User Interaction Techniques," Master's Thesis, June 1986.

P. Collins, "Fractal Geometry and Its Application to Computer Graphics," Master's Thesis, June 1987.

DEPARTMENT

OF

MATHEMATICS

DEPARTMENT OF MATHEMATICS

The focus of the research in the Department of Mathematics has been in the areas of numerical analysis, statistical analysis and the use of microprocessors in support of teaching.

NUMERICAL ANALYSIS

R. H. Franke is developing mathematical principles to interpolate meteorological data from random points to a uniform grid. He is continuing the investigation of the use of thin plate splines in interpolation schemes and has been testing two of the commerical interpolation software packages.

STATISTICAL ANALYSIS

T. Jayachandran, with Professor H. Larson of the Department of Operations Research, has continued the efforts to provide statistical support to enhance the Air Force Oil Analysis Program. They were also involved in the development of an experimental design and the associated data analysis, to evaluate a new Portable Wear Metal Analyzer.

MICROCOMPUTERS

C. O. Wilde has been investigating the use of microprocessors and machine language programming, in support of classroom instruction.

Title: Interpolation of Scattered Meteorological Data

Investigator: R. Franke, Professor of Mathematics

Sponsor: Naval Air System Command

Objective: Develop mathematical principles which may be used to
                    interpolate meteorological information from randomly
                    located points to a uniform grid while maximizing
                    observation utility.

Summary: The use of Laplacian smoothing splines (LSS) for a
                    unified approach to objective analysis; using all
                    data (first-guess and observations) to approximate
                    the underlying variable has been investigated. Use
                    of generalized cross validation to determine the
                    smoothing parameter is not reliable nor cost
                    effective. LSS may be very effective in data sparse
                    areas and this will be investigated soon.

                    Properties to be satisfied by empirical covariance
                    functions for statistical interpolation processes
                    have been studied. Some schemes for generating
                    suitable functions have been found.

Publications: R. Franke, "Sources of Error in Objective Analysis",
                    MWR 113 (1985) 260-270.

                    R. Franke, "Laplacian Smoothing Splines with Gener-
                    alized Cross Validation for Objective Analysis of
                    Meteorological Data", NPS Technical Report,
                    NPS-53-85-0008, August 1985.

Title: Operational Evaluation of The Perkin-Elmer Portable
                    Wear Metal Analyzer (PWMA)

Investigators: T. Jayachandran, Professor Mathematics and
                    H. J. Larson, Professor of Operational Research and
                    Statistics

Sponsor: Naval Air Engineering Center, Lakehurst, N. J.

Objective: To assist in the development of a field test plan to
                    evaluate a newly developed Portable Wear Metal
                    Analyzer (PWMA) in an operational environment,
                    perform the necessary statistical analyses and
                    construct decision tables for monitoring aircraft
                    engine condition for use in the oil analysis program.

Summary: The test plan has been developed and implemented.
                    The data is being evaluated and some preliminary
                    reports have been issued. A final technical
                    report will be issued at the completion of the
                    evaluation.

Title:	Statistical Analyses For The Joint Oil Analysis Program
Investigators:	T. Jayachandran, Professor of Mathematics and H. J. Larson, Professor of Operations Research and Statistics
Sponsor:	Kelly Air Force Base, Texas
Objective:	To support and enhance the performance of the joint oil analysis program in on-condition-maintenance of aircraft engines and other equipment.
Summary:	This is a continuing project to assist in the improvement of the joint oil analysis program. A statistical algorithm, developed under this project, for computer evaluation of the wear metal readings from the spectrometer has been coded for the Z-100 and is being tested at Barksdale AFB. Technical consultation for the development of a new software to automate the spectrometer standardization/ calibration process is being provided. The data from the correlation program to monitor and certify the oil analysis laboratories is being monitored with a view towards suggesting refinements and improvements.
Publications:	None. A technical report is forthcoming.

DEPARTMENT

OF

ADMINISTRATIVE SCIENCES

DEPARTMENT OF ADMINISTRATIVE SCIENCES

The Department of Administrative Sciences is responsible for academic programs designed to educate officers and DoD civilian employees in a variety of functional management specialties. The diversity of faculty's professional expertise is reflected in the wide variety of research projects conducted in the department.

In addition to the permanent staff, the department research effort was augmented by, and has benefitted from, the presence of a number of adjunct professors. The research projects span broad spectra of public sector management issues, ranging from basic scholarly pursuits to applied research designed to assist policy and operational decision making. For ease of exposition the research projects may be grouped into the following areas: acquisition; logistics; information systems; communication systems; financial management; manpower analysis; personnel,training and testing; and organizational sciences.

ACQUISITION

Research in acquisition focuses on competition of major weapon systems during the production phase. Under the support of Navy Office for Acquisition Research, David Lamm developed a methodology for analyzing acquisition strategies and for determining ability to achieve competition during the production phase. Dan Boger and Shu Liao analyzed alternative dual award quantity-split models and nonrecurring cost estimation procedures under a dual source procurement environment.

LOGISTICS

Alan McMasters continued his research effort to address the question of when inventory management of an item should be transferred from NAVELEX to the Ships Parts Control Center. In collaboration with Professor Richards of the OR Department, Professor McMaster has developed a Mean Supply Response Time initial provisioning model for Naval Fleet Material Support Office, which was formally accepted by the Navy (OP-14). Current focus of the joint efforts turned towards developing a repairables replenishment model to complement the provisioning model.

INFORMATION SYSTEMS

A new research project on group decision support systems was initiated by Tung Bui. The objective is to develop algorithms for supporting group decision making for geographically dispersed players. Dan Dolk completed the second phase of a two year project with Army Military Personnel Center designed to build a prototype dictionary system to manage information resources. Professor Dolk also completed the second phase of an ongoing project with Naval Ocean Systems Center and developed a relational model of an information resource dictionary system. Professor Sivasankaran began the initial phase of project modeling and designing symbolic-numeric interfaces for an expert system.

31

Naval Personnel Research and Development Center supported Norman Lyons to study general problem solving skills that distinguish effective computer problem solvers from less effective ones. Professor Lyons also completed a project for the National Communication Systems which resulted in the development of a pair of decision support systems for its Fly-Away Management Systems. The third project undertaken by Professor Lyons is to assist the manpower analysis faculty in the department in the development of a knowledge-based systems for manpower model management.

Norman Schneidewind developed models, concepts and design methodologies in the areas of computer networks and distributed systems for Fleet Material Support Office and Naval Supply Systems Command. Professor Schneidewind also developed models for analyzing and predicting the performance of the IBM VM/370/CMS operating system running in IBM 3033 hardware.

COMMUNICATION SYSTEMS

J. W. LaPatra, C. R. Jones, J. Wozencraft (Department of Computer and Electrical Engineering), and J. Yee (Dept. of Operations Research) studies the demand for services for the National Communications Systems (NCS) and provide recommendations regarding the development, acquisition, and operation of the Nationwide Emergency Telecommunications Network. Professors LaPatra, Jones, Lyons, Yee, and Sovereign (C3) also contributed to the design of the Nationwide Emergency Telecommunications System and provided support of NCS emergency management responsibilities.

FINANCIAL MANAGEMENT

Jerry McCaffery studied the behavior of budget offices in DON and DOD, focusing on the PPBS process. Joseph San Miguel examined the cost effectiveness of leasing as an alternative financing strategy for DON and DOD. Professor San Miguel also continued his research on the efficiency and effectiveness of the cash management systems within the Department of the Navy. K. J. Euske and S. L. Ansari began a project which would document, evaluate and validate the cost accounting systems used by depots. The project was funded by the Office of the Assistant Secretary of Defense (A&L).

MANPOWER ANALYSIS

George Thomas undertook several projects, all sponsored by the U.S. Army Recruiting Command. The first reviewed studies and data for developing a model for forecasting enlistment of older age enlistees. The second was designed to construct a study plan for developing Army Reserve manpower supply and unit location models. The third project, with Kathy Kocher, determined the various factors that affect Army Reserve attrition. The fourth, also with Kathy Kocher, was the first of a comprehensive three-year study designed to examine the Army reserve market.

The U.S. Army Recruiting command also sponsored several projects conducted by R. A. Zimmerman and D. C. Zimmerman. The first examined the effectiveness of using the American College Testing Program's Assessment file in recruiting "college-bound" youth to fill highly specialized enlisted positions. The second project developed and validated preenlistment screening composites for Army applicants. The third project examined personal and organizational factors related to Delayed Entry Program attrition. D. C. Zimmerman also developed a data base for ship readiness analyses.

D. R. Henderson analyzed different enlistment bonuses as a way to achieve level-loaded accessions. Directorate for Accession Policy--Office of Assistant Secretary of Defense and Navy Personnel Research and Development Center jointly sponsored a project by M. J. Eitelberg and N. A. Nieboer-Turpin. The project examined a broad range of the quality of the enlisted force and accession policy. M. J. Eitelberg and J. R. Goral created and analyzed several data files and merged data files on enlisted accession and active duty military personnel, which are linked with personnel security data bases for use in the Personnel Security Program.

PERSONNEL, TRAINING AND TESTING

N. A. Nieboer-Turpin evaluated the efforts to supplement the DOD Student Testing Program with commercial aptitude tests. A related project determined whether offering an interest inventory in conjunction with the Defense Student Testing Program will increase the quantity of juniors and seniors tested with the Armed Services Vocational Aptitude Battery.

R. A. Weitzman studied the use of the Rasch Model in sequential testing for selection of school or job applicants. Professor Weitzman also collaborated with T. G. Sticht and L. A. Armijo in the development and evaluation of functional reading materials for Navy enlisted personnel. Bruce Bloxom conducted a statistical analysis of the validity and reliability of computerized adaptive testing of enlisted personnel. In a related project, Professor Bloxom developed methods for improving the validity and reliability of ability tests by combining response time and response choice.

ORGANIZATIONAL SCIENCES

C. K. Eoyang and R. T. Harris continued to provide research, analysis, training, and consultation support to the Navy's Human Resource Management Support System at both field and staff levels. Professors Harris and McGonigal studied the salient attributes of high performing military organizations and determined the consensus views held by senior leaders of what contributes to "excellence" in military organizations. Professors McMasters, Thomas and Kocher provided TRADOC Research Element Monterey (TREM) assistance with the maintenance and development of Army models of military organizational effectiveness.

33
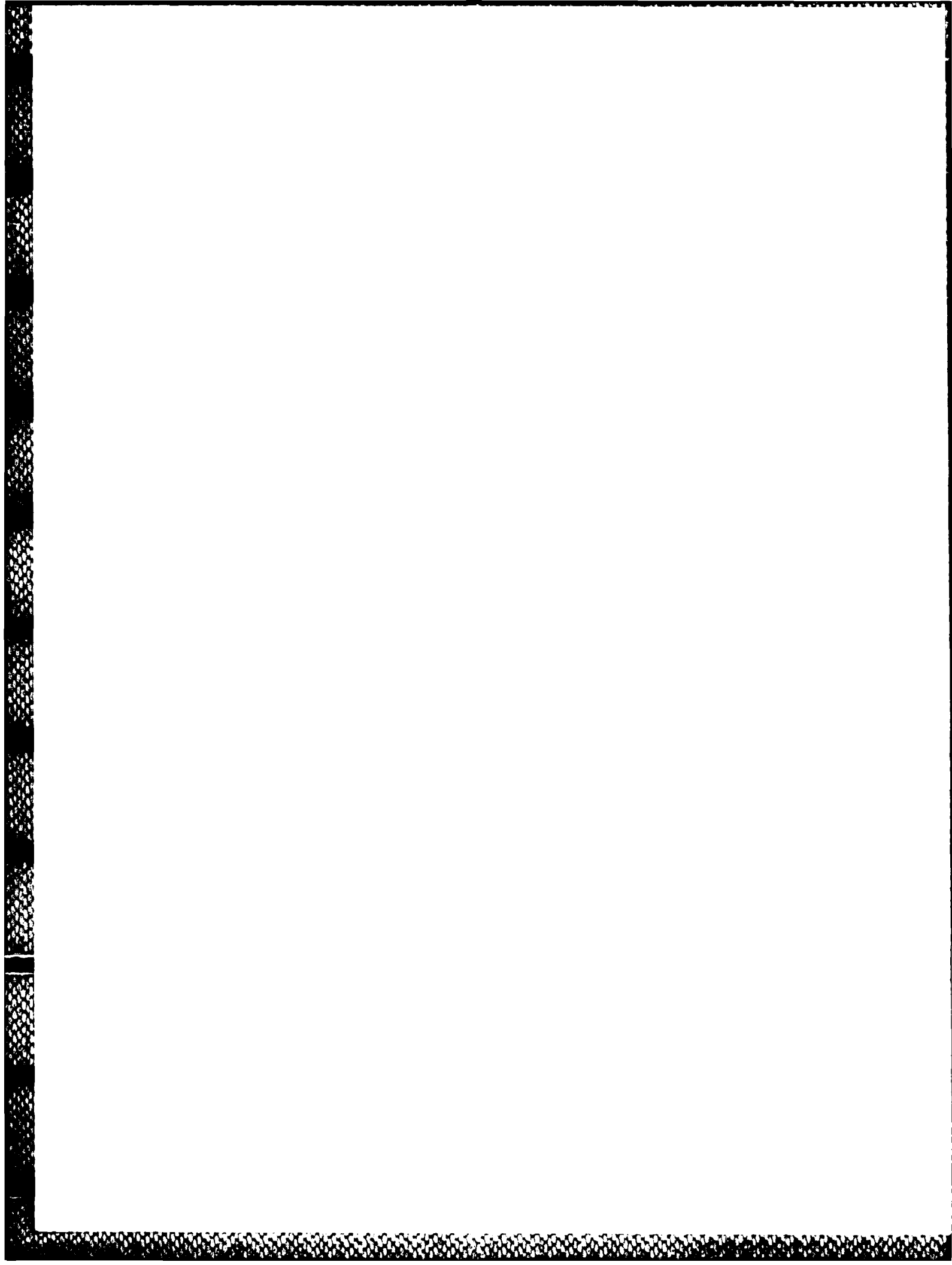
Title:	Psychometric Modelling of Response Time
Investigator:	B. M. Bloxom, Adjunct Research Professor of Psychology
Sponsor:	None
Objective:	To develop methods for improving the validity and reliability of ability tests by combining response time and response choice.

Summary:	Ability tests are usually scored without utilizing the time required to answer test items. With the advent of computerized administration of tests, response times can be recorded and employed to improve the precision of estimates of abilities.

In the current reporting period, a statistical model was developed to express the joint distribution of response time and response choice as a function of ability. The model was distinctive in that it made no strong assumptions about the parametric form of the response time distribution. |

Publication:	B. M. Bloxom, "Considerations in Psychometric Modelling of Response Time," _Psychometrika_, 50, December 1985 (in press).
Conference Presentation:	B. M. Bloxom, "Considerations in Psychometric Modelling of Response Time," Psychometric Society, Nashville, Tennesee, 2-4 June 1985.

B. M. Bloxom, "Considerations in Psychometric Modelling of Response Time," European Meeting of Psychometric and Classification Societies, Cambridge, England, 2-5 July 1985. |

Title: Statistical Analysis of Computerized Adaptive
                        Testing

Investigator: B. M. Bloxom, Adjunct Research Professor of
                        Psychology

Sponsor: Manpower and Personnel Laboratory, Navy Personnel
                        Research and Development Center

Objective: To investigate the validity and reliability of
                        computerized adaptive testing of enlisted personnel;
                        to study the equivalence of results obtained by
                        computerized adaptive testing and conventional paper-
                        and-pencil testing.

Summary: In an effort to reduce military entrance testing
                        time and to enhance the security of test items, the
                        Navy will implement a computerized adaptive adminis-
                        tration of the Armed Services Vocational Aptitude
                        Battery (ASVAB) at Military Entrance Processing
                        Command stations. In this form of testing, each
                        recruit will be administered, by computer, only
                        items which have difficulty levels tailored to his
                        or her ability. A statistical model will be
                        employed to estimate the recruit's performance on a
                        paper and pencil form of the ASVAB.

                        In the current reporting period, the statistical
                        model was modified for use with test items which
                        are multidimensional, i.e. for which more than one
                        kind of ability determines individual differences
                        in responses to the items. A method was developed
                        to equate two sets of multidimensional items so that
                        each of the abilities assessed by them can be meas-
                        ured on the same scale. Also, a method was developed
                        to estimate the multiple abilities adaptively, i.e.
                        to update the estimate of each ability after an
                        individual responds to each item.

36

Title:	An Analysis of Quantity-Split and Nonrecurring Costs Under Competitive Procurement Environment
Investigator:	D. C. Boger, Associate Professor of Economics and S. S. Liao, Professor of Accounting
Sponsor:	Naval Air Systems Command
Objectives:	To analyze alternative quantity-split procedures and to assess nonrecurring cost estimation procedures under a competitive procurement environment.

Summary: This study examines current estimation practices, presents several models of nonrecurring costs, and analyzes the key components of nonrecurring costs experienced by several programs. We conclude that, if there is to be any progress in modeling these non-recurring costs, a reasonably standard cost element structure must be adopted to ensure compatibility of cost elements across systems and that fixed cost components be separated from variable cost components in the cost element structure.

We analyze actual step-ladder bid prices of three major weapon systems to identify price gaming strategies used by contractors in bidding. Five alternative quantity-split models were analyzed. The results show that none of these models is capable of coping with contractor price gaming. We conclude that a new quantity-split model is necessary if the government is to maintain competitive pressure in dual source environment.

Publication:	D. C. Boger and S. S. Liao, "An Analysis of Quantity-Split and Nonrecurring Costs Under Competitive Procurement Environment," Part I and Part II, NPS Technical Reports, NPS54-85-08 and NPS54-85-09, September 1985.
Thesis Directed:	J. K. Stout, "An Analysis of Quantity Split Strategy Under Dual Source Competition," Master's Thesis, September 1985.

Title:	A Dictionary for Model Management
Investigator:	D. R. Dolk, Assistant Professor of Management Information Systems
Sponsor:	U.S. Army Military Personnel Center
Objective:	This is the second and final phase of a two year project with MilPerCen designed to build a prototype dictionary system to manage information resources. The initial phase involved the requirements analysis and preliminary design of a dictionary to support the Force Manpower Operations Center decision support system. This phase has expanded the scope to include other information systems within the DCSPLANS Branch of MilPerCen.

Summary:	A prototype dictionary was built using dBASEII and populated with data provided by MilPerCen. A second version of the dictionary was built to be compatible with the recently developed IFIPS standards for information resource dictionary systems. Procedures were described for implementing active data integrity constraints using the dictionary. A migration path for implementing a mainframe version of the prototype was detailed. An organizational approach to more effective information resource management was recommended.

Publications:	D. R. Dolk and R. Kirsch, "A Relational Information Resource Dictionary System," in progress. To be submitted to the Communications of the ACM. D. R. Dolk, "Implementing Information Resource Management in DCSPLANS," NPS Technical Report, in progress.
Conference Presentation:	D. R. Dolk and A. F. Noel, "A Relational Dictionary Prototype for Implementing Model Management." To be presented at the 19th Hawaii International Conference on Systems Sciences, 8-10 January 1986.
Theses Directed:	R. E. Broome, "An Analysis of Information Resource Management within the Deputy Chief of Staff for Plans U.S. Army Military Personnel Center," Master's Thesis, March 1985. R. M. DiBona, "Use and Design of an Active Data Dictionary for Local Validation of Input Data," Master's Thesis, March 1985

Theses Directed: R. L. Kirsch, "Design and Implementation of a Relational Information Resource Dictionary Compatible with the IFPS Standards," <u>Master's Thesis</u>, December 1985.

A. F. Noel, "Prototyping with Data Dictionaries for Requirements Analysis," <u>Master's Thesis</u>, March 1985.

Title: A Distributed Dictionary/Directory System for the
                    Oracle DBMS

Investigator: D. R. Dolk, Assistant Professor of Management
                    Information Systems

Sponsor: Naval Ocean Systems Center (NOSC)

Objective: This is the second phase of an ongoing project. The
                    first phase analyzed the dictionary capabilities of
                    the ORACLE DBMS and recommended development of a
                    relational model of a dictionary/directory system
                    using existing ORACLE features.

Summary: A relational model of an information resource
                    dictionary system was developed which was compatible
                    with the IFIPS dictionary standards. A prototype
                    system was implemented on ORACLE.

Publication: D. R. Dolk and R. Kirsch, "A Relational Information
                    Resource Dictionary System," in progress (to be
                    submitted to the Communications of the ACM).

Conference   D. R. Dolk and A. F. Noel, "A Relational Dictionary
Presentation: Prototype for Implementing Model Management," to be
                    presented at the 19th Hawaii International Confer-
                    ence on Systems Sciences, 8-10 January 1986.

Theses Directed: M. G. Dedeoglu, "An ORACLE-Based and Prolog-Based
                    Information Resource Dictionary System," Master's
                    Thesis, December 1985.

                    R. L. Kirsch, "Design and Implementation of a
                    Relational Information Resource Dictionary Compatible
                    with the IFPS Standards," Master's Thesis, December
                    1985.

Title:	Analyses in Support of the Defense Manpower Data Center
Investigators:	M. J. Eitelberg, Adjunct Research Professor of Public Administration J. R. Goral, Adjunct Research Professor of Psychology
Sponsor:	Defense Manpower Data Center (DMDC)
Objective:	To create and analyze several data files and merged data files on enlisted accession and active duty military personnel.
Summary:	This is an ongoing project. Project personnel have designed special data files and conducted several manpower studies and analyses on a DOD-wide basis. Task areas during the current period have included the following: enlisted selection and classification standards; DOD personnel security program; systems development of the Defense Enrollment Eligibility Reporting System (DEERS); indices of personnel quality and DOD accession policy; ship manpower readiness; delayed entry program (DEP) attrition; factors for selecting highly-qualified high school nongraduates; and the college-bound market of males for military enlistment.
Publications:	M. J. Eitelberg, Department of Defense, Population Representation in the Active Duty Military Services, Fiscal 1984, Washington, DC, Office of the Assistant Secretary of Defense (Manpower, Installations and Logistics), June 1985. W. H. King and D. C. Zimmerman, Data Base Development for Ship Readiness Analyses, DBM/M-TR-0056-84, Monterey, California, BDM Services Company, November 1984. E. S. Flyer, First-Term Attrition Among Enlisted Personnel Grouped by Racial/Ethnic Background, BDM/M-TR-0051-84, Monterey, California, The BDM Corporation, October 1984. J. R. Goral, DOD Personnel Security Research Reports, 85-1 through 85-14 (a series of 14 Technical Memoranda), Monterey, California, Naval Postgraduate School, 1985.

Title:	Enlisted Force Quality: Applications for Accession Policy
Investigators:	M. J. Eitelberg, Adjunct Research Professor of Public Administration N. A. Nieboer-Turpin, Adjunct Research Professor of Psychology
Sponsor:	Directorate for Accession Policy, OASD (MI&L); Navy Personnel Research and Development Center
Objective:	The objectives of Task II were to evaluate measures of the quality of the enlisted force and changes in the tested aptitudes of draftees and enlistees over time; establish occupational "qualification rates" for selected population subgroups; and examine the participation of American youths in the all-volunteer military.
Summary:	The project resulted in a comprehensive evaluation of the types of persons in the general population who would probably qualify for enlistment and assignment to training in the various occupational areas within each of the Armed Services. Occupational "qualification rates" were established for selected subgroups (e.g. by gender, racial/ethnic group, education, and other descriptive variables) within the population of military-age youths, and the implications of the "qualification rates" for military manpower policy were examined.

A study was also made of certain personnel "quality" measures of the active-duty enlisted force. These quality measures were then compared with similar indices of quality in the civilian labor force. The results, along with descriptive statistics on the characteristics of active-duty enlistees, were incorporated in a DOD report to Congress.

A third element of the general project involved a continuing study of "Hispanics and the Military." An annotated bibliography was completed, a data base on veterans was constructed, statistical tables were produced on various phases of military participation, and significant progress was made toward publication of a major book on the subject.

| Publications: | M. J. Eitelberg, M. E. Lathrop and J. H. Laurence, Manpower for Military Occupations, Monterey, California, forthcoming. |

M. J. Eitelberg and J. R. Wood, Hispanics and the Military, Monterey, California, forthcoming.

M. J. Eitelberg, "Historical Data on Hispanics in the U.S. Military," Abstract of Presentation in H.W. Sinaiko et al, Eds., Hispanic Subpopulations and Naval Service, SI/MRAS/TR-11, Washington, DC, Smithsonian Institution, May 1985.

J. R. Wood, Hispanics and the Military: A Selected Annotated Bibliography, Technical Memorandum 85-1, Washington, DC, Directorate for Accession Policy, Office of the Assistant Secretary of Defense (Force Management and Personnel), August 1985.

Department of Defense, Population Representation in the Active Duty Military Services, Fiscal 1984, Washington, Dc, Office of the Assistant Secretary of Defense (Manpower, Installations and Logistics), June 1985.

Directorate for Accession Policy, "ASVAB Testing in Languages Other than English," Information Paper, Washington, DC, Office of the Assistant Secretary of Defense (Manpower, Installations, and Logistics) 1985.

Conference Presentations:

M. J. Eitelberg, "The Implications of Changing Enlistment Test Norms in 1985," Annual Meeting of the American Psychological Association, Los Angeles, California, August 1985.

J. J. Eitelberg, "Hispanics and the Military," ONR Workshop on Hispanic Subpopulations and Naval Service, Arlington, Virginia, 11 December 1984.

Theses Directed:

S. W. Deutermann, "A Feasibility Study of the Assignment of Women to DD-963 (Spruance) Class Destroyers," Master's Thesis, December 1984.

D. Daniels, "Minority Participation in Navy Jobs," Master's Thesis, June 1985.

C. H. Park and P. G. Lee, "A Critical Analysis of U.S. Army Accessions Through Socioeconomic Consideration Between 1970 and 1984," Master's Thesis, June 1985.

R. Bartsch, "Personnel Quality in the Navy" (tentative), Master's Thesis, forthcoming.

Title:	Human Resource Management System: Research and Support Project
Investigators:	C. K. Eoyang, Associate Professor of Management and R. T. Harris, Associate Professor of Management
Associate Investigators:	R. McGonigal, Associate Professor of Management E. V. Haag, Instructor in Management E. Hamilton, Adjunct Professor R. Dreher, Adjunct Professor
Sponsor:	Naval Military Personnel Command (NMPC-6)
Objective:	To provide continuing research, analysis, training, and consultation support to the U.S. Navy's Human Research Management Support System (HRMSS) at both field and staff levels.

Summary: Since FY79, numerous activities were conducted under this project in support of the above objective. Two long-term demonstration projects were undertaken with the goal of improving the capability of HRMC's and documenting the strategy and outcomes of those efforts. The two project sites are HRMC-San Diego and HRMC-Pearl Harbor. Also NPS faculty have delivered training activities at HRMC's and HRMD's throughout the world. NPS faculty planned and managed the Military HRM Symposium held at NPS (November 1978). NPS faculty designed and delivered an annual two-week Advanced OD Course for Navy OD Specialists.

Regarding activities of the past year, the major thrust has been in two areas. Significant resources were employed in teaching advanced conceptual and skill training in OD to consultants in the Navy's HRMSS. These included a two-week course (60 participants) held in Memphis, Tennessee and various on-site training sessions conducted in Europe, Asia, and throughout the United States. Secondly, faculty have provided the sponsor and senior leaders within the HRMSS with management consultation services relevant to policy and implementation of a major reorganization of the Navy OE program.

Title:	Depot Maintenance Cost and Production Accounting and Reporting
Investigators:	K. J. Euske, Associate Professor of Accounting S. L. Ansari, Adjunct Professor of Accounting
Sponsor:	Office of the Assistant Secretary of Defense (A&L)
Objective:	The purpose of this project is to document, evaluate and validate the cost accounting systems used by depots. Of particular interest is the compilation of cost information for reporting to OASD.
Summary:	The study attempts to determine if the depot cost system provides information which is consistent with the requirements of OASD or whether the two cost information systems are "disconnected." If such disconnections are present, the study attempts to determine the sources and causes for such disconnections. The study is designed to use both thesis students and the co-investigators in the research process.
Conference Presentation:	K. J. Euske and S. L. Ansari, "The Use of the Accounting System for Measuring Productivity in a Large-Scale Organization," Seventeenth Annual National American Institute of Decision Sciences Conference, Las Vegas, Nevada, 11-13 November 1985.
Theses Directed:	T. A. Bragg, "Cost Accumulation within the Puget Sound Naval Shipyard," Master's Thesis, June 1985. H. S. Guess, Jr., "Documentation and Evaluation of Depot Maintenance Cost System Coding and Reporting by Department of Defense Depots," Master's Thesis, December 1984. A. I. Kanellos, "Documentation and Evaluation of the Depot Maintenance Interservicing," Master's Thesis, December 1984. E. W. Law, "An Interservice Comparison of Cost Accounting under Department of Defense Instruction 7220.29-H, Department of Defense Depot Maintenance and Maintenance Support Cost Accounting and Production Reporting Handbook," Master's Thesis, December 1984.

S. E. Lehr, "Documentation and Analysis of the "Miscellaneous" Account Category within the DOD Instruction 7220.29-H Depot Level Maintenance Cost Accounting System," Master's Thesis, December 1984.

W. T. Parker, "Documentation and Evaluation of Comparability of Overhead Costs Reported for Depot Level Maintenance," Master's Thesis, December 1984.

Title: Analyses in Support of the Defense Manpower Data
                        Center

Investigator: J. R. Goral, Adjunct Research Professor of Psychology

Sponsor: Defense Manpower Data Center (DMDC)

Objective: To identify program management areas in which automated
                        personnel security data can be utilized to monitor and
                        identify potential weaknesses. Further, to develop
                        file matching techniques for linking personnel security
                        data bases with personnel files relevant to the
                        Personnel Security Program.

Summary: The Defense Central Index of Investigations was edited
                        and matched with personnel master files and enlisted
                        cohort files. Models for recurring management reports
                        were developed to monitor investigation status, clear-
                        ance level, and related information for overall cate-
                        gories of individuals. Several types of inconsisten-
                        cies were detected. Air Force and Army personnel were
                        identified, whose top secret clearances had not been
                        altered to reflect unsuitability discharges. Military
                        personnel were found without the required National
                        Agency Check in their records. Personnel in sensitive
                        occupations requiring top secret clearances were
                        identified without the requisite investigation or
                        clearance. These files and others containing contractor
                        clearance data were analyzed to model the reinvestiga-
                        tion requirements through FY86. Numerical and location
                        finding were developed for military, civilian, and
                        contractor employees of DOD.

Publications: J. R. Goral, "DIS Investigations and Clearance Eligi-
                        bility of Air Force Enlistees Requiring BIs and SBIs,"
                        85-1, October 1984.

                        J. R. Goral, "The DOD Personnel Security Research
                        Program: Initial USAF Findings and Future Areas of
                        Study," 85-2, November 1984.

                        J. R. Goral, "Identification of Unnecessary Background
                        Investigations," 85-3, December 1984.

                        J. R. Goral, "Personnel Security Investigations:
                        Service Differences for Similar Occupations," 85-4,
                        December 1984.

                        J. R. Goral, "Most Recent DIS Investigation and Clearance
                        Information in the DCII at the Beginning of Fiscal Year
                        1985," 85-5, March 1985.

J. R. Goral, "Continued Top Secret and SCI Status of Former Army Personnel with Unsuitability Discharges," 85-6, April 1985.

J. R. Goral, "Continued Top Secret and SCI Status of Former Air Force Personnel with Unsuitability Discharges," 85-7, April 1985.

J. R. Goral, "Security Investigations and Clearances in the DCII at the End of Fiscal Year 1984: A Profile of 2.1 Million Active Duty Military Personnel," 85-8, May 1985.

J. R. Goral, "A Census of Key Data Elements in the Defense Central Index of Investigations (As of 1 April 1985)," 85-9, June 1985.

J. R. Goral, "Cleaning Up the Periodic Review Backlog: Estimates of the Numbers and Location of Military Subjects," 85-10, August 1985.

J. R. Goral, 'Extent of National Agency Checks on Active Military Personnel," 85-11, September 1985.

J. R. Goral, "Number and Locations of DOD Civilian Employees Likely to Require Security Investigation Updates by the End of Fiscal Year 1986," 85-12, September 1985.

J. R. Goral, "Use of DISCO Files to Identify and Locate Potential Periodic Review Subjects," 85-13, September 1985.

J. R. Goral, "Pinpointing the Location of Potential Military Periodic Review Subjects," 85-14, September 1985.

Conference Presentation: J. R. Goral, "The DOD Personnel Security Research Program: Initial USAF Findings and Future Areas of Study," 1984 Worldwide Information Security Workshop, Kirtland AFB, New Mexico, 29 October-2 November 1984.

Title:	Manpower Budget Estimates for the 600-Ship Navy
Investigators:	D. R. Henderson, Adjunct Research Professor of Economics and D. R. Whipple, Professor of Economics
Sponsor:	Deputy Chief of Naval Operations (Manpower)
Objective:	To analyze ways of obtaining manpower for the Navy at least cost.

Summary: The research compared uniform versus targeted enlistment bonuses as a way to achieve level-loaded accessions. I showed analytically that targeted bonuses are cheaper than uniform bonuses for two reasons: (a) the Navy does not have to pay the same high bonus levels in easy months that are required in more difficult months; and (2) even the bonus amount in the most difficult month will be lower than under a uniform bonus. I presented conservative estimates of the cost saving for a hypothetical level-loading accession plan. Under a reasonable set of assumptions concerning the monthly bonus differences required to level-load, I estimated a cost saving of about 35 percent over a uniform bonus system.

Publications: D. R. Henderson, "Achieving Level-Loaded Accessions in the Navy: Uniform versus Targeted Bonuses," Economic Analysis Report, Department of the Navy, Deputy Chief of Naval Operations (Manpower Personnel and Training), Economic Analysis Branch, March 1985.

Conference Presentation: D. R. Henderson, Presented research results to Deputy Chief of Naval Operations (Manpower Personnel and Training), Economic Analysis Branch, 25 June 1985, Washington, DC.

D. R. Henderson, Presented research results to Deputy Assistant Secretary of the Navy (Manpower), 26 June 1985, Washington, DC.

Title:	Ship Readiness Project
Investigators:	W. H. King, The BDM Corporation D. C. Zimmerman, Adjunct Research Instructor of Administrative Sciences
Sponsor:	Office of the Chief of Naval Operations
Objective:	To develop a data base to be used for ship readiness analyses.
Summary:	Files were constructed at the Defense Manpower Data Center (DMDC) for analysis of ship readiness. Navy enlisted personnel attached to the ships in each observed ship class were selected. Service-entry information was supplemented with updated quarterly data, for the quarters ended 7609 to 8303, resulting in individual longitudinal records. The Active Duty Master and Loss Edit provided the entry and quarterly information for each record. Extractions from the 2754 position file were made for computational purposes. In addition, binary coding format was converted to character format on tapes sent to the Center for Naval Analysis (CNA) to meet computer system specifications. These files were used to examine personnel attributes in relation to ship readiness, but also provide excellent sources of data for a variety of theses and applied research applications.
Publications:	W. H. King, D. C. Zimmerman, "Data Base Development for Ship Readiness Analyses," Office of the Chief of Naval Operations, BDM Technical Report BDM/M-tr-0056-84, November 1984.

Title: Acquisition Strategy

Investigator: D. V. Lamm, Adjunct Professor of Administrative Sciences

Sponsor: Navy Office for Acquisition Research (NOAR)

Objective: To develop a methodology for analyzing acquisition
                        strategies and for determining ability to achieve
                        competition during the production/deployment phase
                        of the major weapon systems acquisition process.

Summary: A survey of current acquisition strategies in use by
                        all DOD services was performed to determine the
                        structure and thrust of such strategies. A review
                        of the acquisition literature was accomplished to
                        determine policy, guidance, practices and procedures
                        in developing and implementing an acquisition strat-
                        egy. Interviews were conducted with Navy policy
                        officials regarding acquisition strategy require-
                        ments and DOD project managers concerning strategy
                        implementation problems.

Publications: D. V. Lamm and H. Wilcox, "Implementation of Acquisi-
                        tion Strategy," Acquisition Strategy Workshop, May
                        1984.

                        D. V. Lamm, "Acquisition Strategy," Proceedings of
                        1985 Federal Acquisition Research Symposium,
                        November 1985.

Theses Directed: B. Bissett, "The Acquisition Strategy Development at
                        Program Initiation: Concepts and Realities," Master's
                        Thesis, December 1984.

                        R. Hayes, "Contracting Strategy to Achieve Production
                        Competition for Major Weapon Systems," Master's Thesis,
                        December 1985.

Title: Analytic Capability in Support of the National
                    Communications System

Investigators: J. W. LaPatra, Adjunct Professor of Systems Analysis,
                    C. R. Jones, Professor of Information and Telecom-
                    munication Systems, J. Wozencraft, Professor of
                    Electrical Engineering, and J. Yee, Adjunct Professor
                    of Operations Research

Sponsor: National Communications System

Objective: To provide recommendations regarding the development,
                    acquisition, and operation of the Nationwide Emer-
                    gency Telecommunications Network (NETS).

Summary: The development, acquisition and operation of the
                    NETS can be analyzed in terms of the supply of ser-
                    vices and the demand for those services. The supply
                    of services involves the development and implementa-
                    tion of routing and flow control procedures that
                    will maximize connectivity in a post attack environ-
                    ment. Since the surviving assets of the nation wide
                    telecommunications system are uncertain, the proce-
                    dures must be robust and the prior attack location
                    of post attack system reconstitution equipment must
                    be carefully chosen. The demand for services was
                    studied based on the mission and planned organiza-
                    tion structure and processes post attack. This
                    involved the creation of a new technique to develop
                    communication requirements from planned command and
                    control system structure and process.

Theses Directed: R. J. Stahel, "An Evolving Digital Telecommunica-
                    tions Industry and Its Impact on the Operational
                    Environment of the Nationwide Emergency Telecommuni-
                    cation System (NETS)," Master's Thesis, March 1985.

                    C. R. Pierson, "Increased Survivability of the
                    Nationwide Emergency Telecommunications System
                    (NETS)," Master's Thesis, March 1985.

                    M. C. Aaby, "Use of Government Owned, Operated and
                    Maintained Telecommunication Assets to Augment the
                    Public Switched Network," Master's Thesis, March
                    1985.

                    R. B. Bell, "Integration of Fiber Optics Technology
                    in the Public Switched Network (PSN) for Augmenta-
                    tion and the Increased Survivability of NETS (Nation-
                    wide Emergency Telecommunications System)," Master's
                    Thesis, June 1985.

Theses Directed: S. Foree, "Secure Transmission of Sensitive Information over the Nationwide Emergency Telecommunications System (NETS)," Master's Thesis, March 1985.

L. Huffman, "The Impact of Current and Evolving Regulatory Policies and Judicial Decisions upon the Effectiveness of the National Communication System," Master's Thesis, March 1985.

J. Hinton, "A Study of the Communications Services Industrial Fund," Master's Thesis, March 1985.

M. Weidert, "Integrated Services Digital Network (ISDN)," Master's Thesis, June 1985.

Title:	Analytical Support for the National Communications System (NCS)
Investigators:	J. W. LaPatra, Adjunct Professor of Systems Analysis, C. R. Jones, Professor of Information and Telecommunications Systems, N. R. Lyons, Associate Professor of Management Information Systems, J. Yee, Adjunct Professor of Operations Research and M. G. Sovereign, Professor of Operations Research
Sponsor:	National Communications System
Objective:	To contribute to the design of the Nationwide Emergency Telecommunications System; and to provide support of NCS emergency management responsibilities.
Summary:	Blocking probabilities were characterized and routing and flow control algorithms were provided. A study of interconnection and interoperability issues produced a characterization of survivability enhancement based on changing topology, mixed media, and tandem office placement. Contributions to the Flyaway Management Information System (FAMIS) were made. These included design of a requirements database and changes in the FAMIS software.
Conference Presentations:	J. W. LaPatra, "Increasing the Survivability of an Emergency Communications Network by Using Redundant Routing," IEEE International Conference on Systems, Man and Cybernetics, Tucson, Arizona, November 1985. J. W. LaPatra, "Mixed Media Routing as a Strategy to Enhance Emergency Communication Network Survival," IEEE Global Telecommunications Conference, New Orleans, Louisiana, December 1985.
Theses Directed:	R. B. Bell, "Integration of Fiber Optics Technology into the Public Switched Network (PSN) for Augmentation and the Increased Survivability of NETS (National Emergency Telecommunications System)," Master's Thesis, June 1985. R. J. Stahel, "An Evolving Digital Telecommunications Industry and its Impact on the Operational Environment of the Nationwide Emergency Telecommunication System (NETS), Master's Thesis, March 1985. M. C. Aaby, "Use of Government, Operated and Maintained Telecommunications Assets to Augment the Public Switched Network, Master's Thesis, March 1985.

54

Theses Directed: S. C. Foree, "Secure Transmission of Sensitive
                    Information via the Nationwide Emergency Telecommuni-
                    cations System (NETS)," Master's Thesis, March 1985.

                    T. L. Edgell, "A Management Strategy for the Naval
                    Administrative Telephone System," Master's Thesis,
                    March 1985.

                    J. M. Hinton, "A Study of the Communications Services
                    Industrial Fund," Master's Thesis, March 1985.

                    L. K. Huffman, "The Impact of Current and Evolving
                    Regulatory Policies and Judicial Decisions Upon the
                    Effectiveness of the National Communications System,"
                    Master's Thesis, March 1985.

                    R. Pierson, "Increased Survivability of the Nation-
                    wide Emergency Telecommunications Systems (NETS)
                    Through Redundant Routing," Master's Thesis, March
                    1985.

Title: The Basis for Technological Literacy: Experiments
                      in Exploration

Investigator: N. R. Lyons, Associate Professor of Management
                      Information Systems

Sponsor: Naval Personnel Research and Development Center (NPRDC)

Objective: The objective of this research is to identify general
                      problem solving skills that distinguish effective
                      computer problem solvers from less effective ones.

Summary: Technological literacy is an area of increasing
concern to the Navy. As computer technology becomes
pervasive, it is necessary to understand why some
individuals adapt readily to machines while others
do not. We need to know more about the skills that
form the basis for technological literacy.

Contrary to our expectations, mental imagery or advance
organizers seemed to have little to do with success
at the problem solving task. There seemed to be two
principal determiners of success. The first was the
way the subject chose to constrain the task. The
second was the level of general problem solving skill
that the subject brought to the task.

Title: A Decision Support System for the National
                    Communications System

Investigator: N. R. Lyons, Associate Professor of Management
                    Information Systems

Sponsor: National Communications System

Objective: There were several objectives in this project.

                    1. Determine how to speed up the current FAMIS
                        prototype.

                    2. Determine how to structure and integrate EPMIS
                        and FAMIS.

                    3. Suggest approaches to long-term FAMIS structure
                        and design.

                    4. Suggest administrative approaches for EPMIS/FAMIS.

Summary: The Office of the Manager of the National Communica-
                    tion System (NCS) requires timely accurate information
                    about communications resources during national disas-
                    ters. This led to the development of a pair of
                    decision support systems (DSS) for the National
                    Emergency Management teams. These systems are the
                    Emergency Preparedness Management Information System
                    (IPMIS) and the Fly-Away Management System (FAMIS).

                    This report covers the FAMIS system. FAMIS currently
                    exists as a prototype written in BASIC and implemented
                    on portable Otrona microcomputers. The prototype is
                    in an early stage of development. It has been useful
                    for defining the final system.

                    Now that the concept has been developed, it is time to
                    move beyond the prototype stage. NCS must start a
                    disciplined development effort. The remainder of this
                    report deals with the definition of the problem and
                    the process of setting up a development effort.

Title: Knowledge Based Systems for Manpower Model Management

Investigator: N. R. Lyons, Associate Professor of Management
                    Information Systems

Sponsor: Manpower Program, Administrative Sciences Department
                    Naval Postgraduate School

Summary: A major problem for the Manpower Program has been
                    keeping track of their databases and models. This
                    program seemed ideally suited for the development
                    of a knowledge based system for model and data
                    management. Such a system could be used to store
                    and collate information about the models used by
                    the system.

58

Title: Stock Coordination Management between NAVELEX and
                      SPCC

Investigator: A. W. McMasters, Associate Professor of Operations
                      Research and Administrative Sciences

Sponsor: Naval Electronics Systems Command

Objective: This is a continuing research effort addressing the
                      question of when inventory management of an item should
                      be transferred from NAVELEX to SPCC.

Summary: The problem of stock coordination between NAVELEX and
                      SPCC became more complex this year because of the stock
                      funding of depot level repairables. Any items which
                      are now transferred to SPCC to manage must be approved
                      by DOD based on their impact on the stock fund. 2Z cog
                      items managed by NAVELEX are not stock funded and are
                      free to the customer. After transfer to SPCC they
                      become 7G cog and the customer must buy them out of
                      his OPTAR. As a consequence, stock coordination has
                      been temporarily halted until a methodology can be
                      developed for forecasting the needed increase in stock
                      funds and incorporating those forecasts in the POM
                      process. The research conducted this year concentrated
                      on ways to increase DOD funding support by 2Z cog
                      spares for those items experiencing random demands.
                      The major conclusions were that NAVCOMPT policy should
                      recognize that some 2Z items do indeed experience ran-
                      dom demand and provide the necessary procurement and
                      repair funds so that the fleet is better able to
                      operate. NAVELEX should take advantage of the new
                      Total Carcass Tracking System program so that the 2Z
                      carcass loss rates can be reduced since replenishment
                      procurements are not currently being funded.

Thesis Directed: R. R. and L. J. Bird, "An Analysis of the Advice Codes
                      and Priorities Placed on 2Z Cognizance Requisitions,"
                      Master's Thesis, December 1984.

Title: Evaluation of Efforts to Supplement the DOD Student
                    Testing Program with Commercial Aptitude Tests

Investigator: N. A. Nieboer-Turpin, Adjunct Research Professor of
                    Psychology

Sponsor: Office of the Assistant Secretary of Defense (Manpower,
                    Installations and Logistics), Director of Accession
                    Policy

Objective: To provide a detailed evaluation of the supplemental
                    commercial student testing program, with recommenda-
                    tions for future application to improve the Defense
                    Student Testing Program.

Summary: Defense-subsidized commercial aptitude testing was
                    conducted in the Midwest, West, and New England
                    during 1982-83. Information about the program was
                    obtained from the testing agencies, school officials,
                    students, and the Services. Public perceptions of
                    the program were favorable, students expressed
                    interest in learning about Defense training and educa-
                    tion programs, and Service recruiters found the
                    detailed information about prospective enlistees to
                    be helpful. Favorable interim recommendations led
                    to the continuation of a modified supplemental apti-
                    tude testing pilot project in School Year 1983-84.

Publication: N. A. Nieboer, "Evaluation of Commercial Aptitude
                    Testing as a Supplement to the DOD Student Testing
                    Program," Office of the Assistant Secretary of
                    Defense (Manpower, Installations & Logistics), July
                    1984 (actually printed in FY 1985).

60

Title: Offering Commercial Aptitude Testing in the Department
                        of Defense Student Testing Program: A Continuation
                        in School Year 1983-84

Investigator: N. A. Nieboer-Turpin, Adjunct Research Professor of
                        Psychology

Sponsor: U.S. Army Recruiting Command, U.S. Air Force
                        Recruiting Service, U.S. Marine Corps

Objective: To evaluate the modified supplemental commercial
                        student testing program, with recommendations for
                        future improvements in Defense Student Testing
                        Programs.

Summary: Arrangements for continued Defense-subsidized com-
                        mercial aptitude testing in the Midwest and West
                        were completed, and testing proceeded as planned.
                        Reports from the Services indicated that contribu-
                        tions derived from the project included: entree
                        into schools which had refused the Armed Services
                        Vocational Aptitude Battery (ADVAB), increased
                        access in about half the participating schools,
                        increased scheduling of ASVAB among non-user schools,
                        the testing of students not otherwise exposed to a
                        DOD testing experience, comprehensive leads from
                        students requesting information about military pro-
                        grams, time savings for recruiting personnel, and
                        increased enlistments. It was recommended that
                        recent changes in the student ASVAB program be
                        evaluated, and that the DOD Student testing Program
                        as a whole be considered with respect to its value
                        in meeting the needs of the recruiting commands.

61

Title: Project Interest Inventory (PII): A Study of the
                    Effects of Offering Interest Measurement with the
                    ASVAB in the DOD Student Testing Program

Investigator: N. A. Nieboer-Turpin, Adjunct Research Professor of
                    Psychology

Sponsor: Office of the Assistant Secretary of Defense (Man-
                    power, Installations and Logistics), Director of
                    Accession Policy and Navy Personnel Research and
                    Development Laboratory

Objective: To determine whether offering an interest inventory
                    in conjunction with the Defense Student Testing
                    Program will increase the quantity of juniors and
                    seniors tested with the ASVAB.

Summary: Operational constraints required the limitation of
                    the interest inventory offer to a three-month period
                    (15 November 1984-15 February 1985). Within this
                    timeframe, the project did not increase the percent-
                    ages of juniors and seniors tested with the ASVAB.
                    Despite an overall decrease in percentages of stu-
                    dents tested with ASVAB, however, schools participat-
                    ing in the interest inventory project did appear to
                    show a slightly smaller decrease than did the non-
                    participants. The fluctuations in ASVAB usage for
                    the 1985-86 school year depended to an unknown degree
                    on the introduction of a new form of the test, and
                    to other operational changes introduced early in the
                    school year. The PII concept was endorsed by 91
                    percent of participating counselors and 58 percent
                    of nonparticipants. About 70 percent of partici-
                    pants and 55 percent of nonparticipants stated they
                    would be inclined to test more students with ASVAB,
                    if offered an interest inventory in the future. It
                    was recommended that no steps be taken to implement
                    the PII concept without further testing in a more
                    stable environment (i.e. after both school and DOD
                    marketing personnel have become accustomed to the
                    recent changes in the ASVAB program, and with ample
                    advance planning time for the schools).

Publication: N. A. Nieboer-Turpin, "Project Interest Inventory:
                    An Overview," Office of the Assistant Secretary of
                    Defense (Manpower, Installations & Logistics), in
                    progress.

Conference
Presentation:

N. A. Nieboer-Turpin, "Project Interest Inventory: An Overview," American Vocational Association, New Orleans, Louisiana, December 1984; and American Association for Counseling and Development, New York, April 1985.

Title:	Research on Cash Management Programs Within the Department of the Navy
Investigator:	J. G. San Miguel, Professor of Accounting
Sponsor:	Navy Accounting and Finance Center
Objective:	The objective of this long-term research program is to investigate the efficiency and effectiveness of the cash management systems within the Department of the Navy. Within this scope it should also be possible to provide an assessment of the potential for fraud, waste, and abuse in the collection, safekeeping, and disbursement of cash. In addition, the cash management systems employed within DON can be evaluated for compliance with Department of the Treasury rules and regulations.
Summary:	Research is progressing on a number of projects related to cash management. The research programs are being executed by masters thesis students in financial management. One project was completed in September 1984 and six were completed prior to October 1, 1985. The completed research projects focus on the implementation of the Department of the Treasury's cash management improvement initiatives within DON. These empirical studies including the lock box system are: an examination of a commercial draft system for replacing imprest funds; an evaluation of the use of travelers checks and credit cards for travel within DON; a review of the cash management programs within the Marine Corps; an evaluation of intercorporate electronic drafts for payments to contractors; and cash management within the Navy Industrial Fund. All field work and data accumulation on these projects has been completed.
Theses Directed:	J. J. Adrzejewski, "An Evaluation of the Application of a Lock Box System Within the Department of the Navy," Master's Thesis, September 1984.

F. C. Alke, "Use of Intercorporate Trade Fund Transfers for Navy Dispursements," Master's Thesis, December 1984.

J. J. Crosby, "Commercial Drafts and Interest Bearing Checking Accounts as Alternatives to Imprest Fund Cash Balances," Master's Thesis, December 1984.

J. W. Farmer, "Cash Management POlicy and Procedures Within the United States Marine Corps," Master's Thesis, December 1984. |

W. C. Weesner, "An Evaluation of Travelers Checks and Credit Cards for Travel," Master's Thesis, December 1984.

C. Ward and M. Balmert, "Identification of Cash Management Opportunities in the Navy Industrial Fund," Master's Thesis, June 1985.

Title: Computer Network Design

Investigator: N.F. Schneidewind, Professor of Administrative Sciences

Sponsor: Fleet Material Support Office and Naval Supply
                          Systems Command

Objective: Develop models, concepts and design methodologies
                          in the areas of computer networks and distributed
                          systems as applied to the design of the Stock Point
                          Logistics Integrated Communications Environment.

Summary: During the past fiscal year the following was
                          accomplished:

                          1) Design of an interconnection strategy for con-
                              necting SPLICE site local networks to the Defense
                              Data Network.

                          2) Development a distributed system design paradigm.

                          3) Design of tactical and strategic SPLICE network
                              performance management plans.

                          4) Design of a security module for SPLICE.

Publications: N. F. Schneidewind, "Local Area Networks," Yearbook
                          of Science and Technology (1986), McGraw-Hill Book
                          Co., 1985, pp. 259-262.

                          N. F. Schneidewind, "Principles of Local Area Net-
                          works," Encyclopedia of Science & Technology, McGraw-
                          Hill Book Co., 6th Edition.

                          N. F. Schneidewind, "Principles of Wide Area Networks,"
                          Encyclopedia of Science & Technology, McGraw-Hill
                          Book Co., 6th Edition.

                          N. F. Schneidewind, "Principles of Teleprocessing,"
                          Encyclopedia of Science & Technology, McGraw-Hill
                          Book Co., 6th Edition.

                          N. F. Schneidewind, "Interconnecting Local Networks
                          to Long-Distance Networks" in Tutorial-Local Network
                          Technology, W. Stallings (ed.), IEEE Computer Society
                          Press, Second Edition, 1985, pp. 356-365 (Reprint).

                          N. F. Schneidewind, "Interconnecting Local Networks
                          to Long-Distance Networks," Datapro Research Reports,
                          Planning, Datapro Research Corporation, November 1984
                          (Reprint).

Conference Presentations:	N. F. Schneidewind, Panel Chairman, "Future of Networking," National Computer Conference, Chicago, Illinois, 18 July 1985.
Theses Directed:	D. Arseneault, "A Security Module Design for the Stock Point Logistics Integrated Communications Environment (SPLICE)," <u>Master's Thesis</u>, March 1985.

S. M. Carr, "Design of User Friendly Protocol to Effect a Transparent Internetwork Transaction Facility Through SPLICE and the Defense Data Network," <u>Master's Thesis</u>, September 1985.

J. Schmidt, "Tactical Network Management for the Stock Point Logistics Integrated Communications Environment," <u>Master's Thesis</u>, September 1985.

D. Blankenship, "Strategic Network Management for the Stock Point Logistics Integrated Communications Environment," <u>Master's Thesis</u>, September 1985.

Title: Computer Performance Evaluation and Modeling

Investigator: N. F. Schneidewind, Professor of Computer Science

Sponsor: Trident Command and Control Systems Maintenance
                  Agency, U.S. Navy

Objective: Develop models for analyzing and predicting the
                  performance of the IBM VM/370/CMS operating system
                  running in IBM 3033 hardware.

Summary: The collection and analysis of performance and user
                  characteristic data was continued.

Title: Experimental Functional Skills Project: Reading

Investigators: T. G. Sticht, Adjunct Research Professor of
                      Industrial Psychology, L. A. Armijo, Adjunct
                      Research Professor and R. A. Weitzman, Associate
                      Professor of Psychology

Sponsor: Chief, Naval Education and Training (CNET)

Objective: To develop and evaluate functional reading materials
                      for Navy enlisted personnel.

Summary: The project is completed except for the assembly of
                      the final two 50-item tests. This work is currently
                      in the process of completion. The test items have
                      been selected to fit the Rasch item-response model,
                      and test scores will be reported as Rasch scores
                      converted and equated to the scale of the California
                      Adult Student Assessment System.

Publications: L. A. Armijo, "A Navy Knowledge Base," Project
                      Report, in progress.

                      L. A. Armijo, "Processing Skills," Project Report,
                      in progress.

Title: Application of Spreadsheet Programs to Manpower
                        Modeling

Investigator: T.G. Swenson, Assistant Professor of Administrative
                        Sciences

Sponsor: NPS Foundation Research Program

Objective: To demonstrate the utility of spreadsheet programs
                        as decision aids in the manpower, personnel and
                        training areas of study.

Summary: The project resulted in the identification and demon-
                        stration of a wide variety of spreadsheet applica-
                        tions to Manpower, Personnel and Training areas
                        such as: 1) Trend analysis, 2) Manpower Planning,
                        3) Markov analysis, 4) Economic analysis of training,
                        5) Compensation analysis, 6) Selection and Recruit-
                        ing evaluation, 7) Promotion Planning, 8) Utility
                        analysis, and 9) Productivity analysis.

Theses Directed: H.T. Styron, "The Application of Microcomputer
                        Spreadsheets to Produce the U.S. Army Five Year Field
                        Grade Officer Promotion Plan," Master's Thesis, Dec.
                        1984.

                        G.T. McCannel, "A Cost Determination Model for the
                        Functional Context Training Revision of Basic Elec-
                        tricity and Electronics Training," Master's Thesis,
                        Dec. 1985.

                        P.R. Stahl, "In Search of Combat Readiness in the
                        U.S. Marine Corps," Master's Thesis, Dec. 1985.

Title:	Army Reserve Market Study

Investigator:	G. W. Thomas, Associate Professor of Economics
	K. M. Kocher, Labor Economist

Sponsor:	U.S. Army Recruiting Command (USAREC)

Objective: This is a three-year study from AY85 through AY88. The objectives of the full project are as follows:

(1) to develop an integrated local labor market geo-demographic/attitudinal data base to support reserve recruiting efforts;

(2) to develop techniques for defining and estimating relevant reserve geo-demographic market areas and market segments;

(3) to develop the theory underlying the prior service supply model;

(4) to develop the non-prior service supply model;

(5) to develop models for optimal allocation of authorizations and recruiters across alternative sites and reserve centers;

(6) to integrate the non-prior service, prior service, and optimal allocation models; and

(7) to test and evaluate the final integrated model at USAREC.

Summary: Objective (1) above was funded in 1984. Data files such as those listed below will be obtained. Relevant data elements will be extracted from these data files and concatenated into master data bases. The master data bases will be created so that standard data extraction/statistical packages may be utilized. The resultant data bases will be made available on the Recruit Marketing Network so that the RAMIS data management system may be utilized.

(a) 1979 Rand Reserve Forces Survey
(b) 1980/81 USAREC Reserve Market Survey
(c) Reserve Component Attitudes Study 1978-82
(d) Youth Attitude Tracking Studies 1983-85
(e) DMDC Reserve Components Common Personnel Data System
(f) National Logitudinal Survey of Youth Labor Market Experience (1979-85)
(g) Census Bureau, Current Population Survey
(h) Census Bureau, Public Use Microdata Sample
(i) Census Bureau, Summary Tape Files I-IV

71

(j)	Census Bureau, <u>County Business Patterns</u>
(k)	Bureau of Labor Statistics, <u>Area Wage Surveys</u>
(l)	Bureau of Labor Statistics, <u>Unemployment in States and Local Areas</u>
(m)	Bureau of Labor Statistics, <u>Employment and Earnings</u>
(n)	University of Michigan, <u>Panel Study of Income Dynamics</u>

Publication: G. W. Thomas, J. Borack and S. Mehay, "Estimating Local Area Manpower Supply for the Reserves," NPS Technical Report, NPS54-85-006, September 1985.

Presentation: On program of 1986 ORSA/TIMS meeting.

Theses Directed: J. Boyle, "Factors Influencing Military Affiliation Intentions of First Term Army Enlisted Personnel," <u>Master's Thesis</u>, December 1984.

D. W. Harris, "An Analysis of Youth Labor Force Transition Probabilities," <u>Master's Thesis</u>, December 1984.

G. Citizen, "A New Device for Estimating Local Area Enlistment Market Potential," <u>Master's Thesis</u>, June 1985.

J. S. Sullivan, Jr., "Motivation of First Term Reserve Reenlistment," <u>Master's Thesis</u>, June 1985.

Title: Army Reserve Recruiting Study Plan

Investigator: G. W. Thomas, Associate Professor of Economics

Sponsor: U.S. Army Recruiting Command

Objective: To construct a study plan for developing U.S. Army
                    Reserve manpower supply and unit location models.

Summary: A study was performed consisting of: (a) a review of
                    economic theory and studies of the various factors
                    that affect Reserve recruiting at the unit level or
                    reserve center level; (b) a review of current reserve
                    recruiting and unit location methods; and (c) a
                    review of current methods of evaluating reserve
                    recruiting.

                    Based on these reviews and on-site systems analysis,
                    we prepared a plan for developing operational Army
                    Reserve recruiting/unit location models. These models
                    are designed to provide measures of market size at
                    unit and higher levels and to determine preferred
                    location for new units that provide adequate recruit-
                    ing markets. This research project, completed in
                    May 1985, resulted in a three year study (Army Reserve
                    Market Study) funded by Army Recruiting Command.

Publication: G. W. Thomas, J. Borack and S. Mehay, "Estimating Local
                    Area Manpower for the Reserves," NPS Technical Report,
                    NPS54-85-006, September 1985.

Presentation: Presentation on program of 1986 ORSA/TIMS meeting.

Theses Directed: J. Boyle, "Factors Influencing Military Affiliation
                    Intentions of First Term Army Enlisted Personnel,"
                    Master's Thesis, December 1984.

                    D. W. Harris, "An Analysis of Youth Force Transition
                    Probabilities," Master's Thesis, December 1984.

                    G. Citizen, "A New Device for Estimating Local Area
                    Enlistment Market Potential," Master's Thesis, June 1985.

                    J. S. Sullivan, Jr., "Motivation of First Term Reserve
                    Reenlistment," Master's Thesis, June 1985.

Title:	Army Unit Capability Study
Investigators:	G. W. Thomas, Associate Professor of Economics K. M. Kocher, Labor Economist A. W. McMasters, Associate Professor of Operations Research and Administrative Sciences
Sponsor:	U.S. Army TRADOC System Analysis Activity
Objective:	To provide TRADOC Research Element Monterey (TREM) assistance with the maintenance and development of Army models of unit effectiveness.
Summary:	This was a continuing project from AY84. The results of this effort were twofold: (1) we conducted research in the area of unit effectiveness/unit readiness modeling; and (2) we assisted TREM in its educational responsibilities as TRADOC proponent for the AMORE (Analysis of Military Organizational Effectiveness) methodology. We identified and recommended potential improvements to the AMORE model.Points of contact with the functional schools and centers were established to assist users in translateing their problems into potential thesis topics for student examination. Principal researchers assisted TREM in conducting a one-week woekshop on AMORE. The project has been taken on by Professor McMasters and a new AS faculty member, Professor Thomas Moore.
Publications:	Analysis of Military Organizational Effectiveness (AMORE) User's Handbook, forthcoming.
Theses Directed:	P. Susalla, "Application of AMORE (Analysis of Military Organizational Effectiveness) Model to Charles F. Adams Class Guided Missile Destroyer," Master's Thesis, December 1984. E. Negrelli, "A Sensitivity Analysis of the AMORE (Analysis of Military Organizational Effectiveness) Model," Master's Thesis, December 1984. H. Fujio, "Reconstitution and Recovery Capability of the Light Infantry Company," Master's Thesis, September 1985.

74

Title:	Enlisted Supply Model for Older Enlistees
Investigator:	G. W. Thomas, Associate Professor of Economics
Sponsor:	U.S. Army Recruiting Command
Objective:	To review studies and data for developing a model for forecasting enlistment of older age enlistees.
Summary:	The purpose of this research was to develop a plan for identifying and quantifying the graduate (post high school) enlistment market. Historical enlistment supply models were reviewed. The resultant study plan proposed a three-year study encompassing the development of an integrated zipcode level graduate market data base, idenfification of graduate market segments, derivation of graduate market potential from the data, and the development of techniques for estimating new contracts from the graduate market based on recruiting goals and resources.
Publication:	G. W. Thomas and K. Kocher, "Costs and Benefits of Older Age Enlistees: A Preliminary Examination," NPS Technical Report, NPS54-84-025, September 1984.
Presentation:	Presentation at 1986 ORSA/TIMS meeting.
Theses Directed:	G. Citizen, "A New Device for Estimating Local Area Enlistment Market Potential," Master's Thesis, June 1985.
	D. W. Harris, "An Analysis of Youth Labor Force Transition Probabilities," Master's Thesis, December 1984.

Title:	USAR Attrition Study
Investigators:	G. W. Thomas, Associate Professor of Economics K. M. Kocher, Labor Economist
Sponsor:	U.S. Army Recruiting Command
Objective:	To determine the various factors that affect Army Reserve attrition.
Summary:	The purpose of this research is to track attrition over time and to isolate factors that are associated with reservists not completing their first terms. The outcome is to develop models that will assist U.S. Army Recruiting command in predicting reserve attrition. The study will be conducted in two phases. Phase I will be a review and critique of DMDC and USAREC data to support attrition. Phase II will be the development of non-prior service attrition models.
Presentation:	Presentation at 1986/87 ORSA/TIMS meeting anticipated.
Thesis Directed.	K. Bucher and C. Murray, "A Multivariate Analysis of USAR Attrition," Master's Thesis, December 1985.

Title:	Development of an Enlistment Suitability Index for the Army
Investigators:	D. C. Zimmerman, Adjunct Research Instructor in Administrative Science R. A. Zimmerman, Adjunct Research Professor of Psychology W. H. King, BDM Corporation
Sponsor:	U.S. Army Recruiting Command
Objective:	To develop and validate preenlistment screening composites for male and female Army applicants.
Summary:	Male and female screening composites were developed using data for non-prior service recruits who enlisted during Fiscal Years 1979 and 1980 and cross-validated on cohorts from Fiscal Years 1981 and 1982. Predictors included educational level, AFQT category, age at entry, term of enlistment and other entry factors related to attrition. Composite scores predictive of first term attrition were developed, validated and compared on the basis of stability in cross-validation, ability to minimize error in predicting stayers who actually did not complete the first term of service, and on the cumulative frequency distributions of composite scores.
Publications:	D. C. Zimmerman, R. A. Zimmerman and W. H. King, "Development and Validation of Preenlistment Screening Composites for Army Enlisted Personnel," Report No. USAREC SR 85-2, Fort Sheridan, Illinois, July 1985. D. C. Zimmerman, R. A. Zimmerman and W. H. King, "Development of an Enlistment Suitability Index for Army Male Applicants," NPS Technical Report, NPS54-85-004, July 1985.
Conference Presentation:	D. C. Zimmerman and R. A. Zimmerman, "Summary of Findings on the Development and Validation of Preenlistment Screening Composites for Army Enlisted Personnel," Army Recruiting Research Coordination Conference, Northbrook, Illinois, October 1985.

Title:	Recruitment of College-Bound Youth Through Use of the ACT Assessment File
Investigators:	R. A. Zimmerman, Adjunct Research Professor of Psychology D. C. Zimmerman, Adjunct Research Instructor in Administrative Science
Sponsor:	U.S. Army Recruiting Command
Objective:	To examine the effectiveness of using the American College Testing Program's Assessment file in recruiting "college-bound" young people to fill highly specialized enlisted positions.
Summary:	Two exploratory studies were conducted to examine the utility of telephone interviews and mail campaigns in stimulating interest among high school students and recent graduates in foreign language training at the Defense Language Institute. The two approaches were compared on the basis of effectiveness in generating leads. Telephone contact generated more leads for seniors than for recent graduates. The lead per contact ratio was higher overall, for the telephone approach than for the mail approach. More mail campaign respondents were males, while more females who were contacted by telephone expressed interest in being contacted by a recruiter. The ACT assessment item showing interest in studying abroad could be used to target students interested in military occupations requiring foreign language training. A profile of characteristics was developed for respondents showing the greatest interest in the DLI and military service.
Publications:	R. A. Zimmerman and D. C. Zimmerman, "Recruitment of College-Bound Youth Through Use of the ACT Assessment File," Report No. USAREC SR 85-1, Fort Sheridan, Illinois, July 1985. R. A. Zimmerman and D. C. Zimmerman, "Use of Market Segmentation and a Personalized Contact Approach in Recruiting the College-Bound," NPS Technical Report, NPS54-85-005, July 1985. R. A. Zimmerman and D. C. Zimmerman, "A Pilot Study on the Use of Specialized Literature in Mail Campaigns in Recruiting Segments of the College-Bound Market," NPS Technical Report, in progress.
Conference Presentation:	R. A. Zimmerman and D. C. Zimmerman, "Summary of Findings on Recruitment of College-Bound Youth Through Use of the ACT Assessment File," Army Recruiting Research Coordination Conference, Northbrook, Illinois, October 1985.

Title: Study of Delayed Entry Program Attrition

Investigators: R. A. Zimmerman, Adjunct Research Professor of
                    Psychology
                    D. C. Zimmerman, Adjunct Research Instructor of
                    Administrative Sciences
                    M. E. Lathrop, Social Science Analyst

Sponsor: U.S. Army Recruiting Command

Objective: To examine personal and organizational factors
                    related to DEP attrition.

Summary: The Delayed Entry Program (DEP) has served a variety
                    of roles in the recruiting process, acting as an
                    integrating or socializing mechanism between civi-
                    lian society and the military structure. DEP attri-
                    tion affects recruiting goal setting, incentives
                    and projected manpower supply.

                    Telephone interviews of 1,000 individuals participating
                    in the DEP during FY84 revealed that most (47 percent)
                    non-medical and non-moral DEP separations occurred
                    because the recruits changed their minds about an Army
                    career. However, only 16 percent of these respondents
                    initially indicated consideration of an Army career.
                    Forty percent of the DEP losses reportedly separated
                    because they were not assigned to the job training
                    they desired. Statistically significant correlations
                    were found between several survey items and change in
                    attitude (thought they wouldn't like Army life). Those
                    provided with information about Army benefits were
                    less likely to become dissatisfied. Family and peer
                    influences were also significantly correlated with
                    attitudinal change. Of the persons surveyed about
                    one-fourth never advised their recruiters of their
                    intent to drop out of the DEP. Ninety-three percent
                    of the recruiters who were informed of such intent
                    took action to persuade their recruits to fulfill their
                    obligations. Most active duty losses reported that
                    they did not like Army life, with nearly 95 percent of
                    the separations occurring during training. Over one-
                    half the DEP enlistees stated that they had joined the
                    Army in order to receive financial aid for college.
                    The discriminant function analysis with the larger
                    canonical correlation showed experience at the MEPS,
                    experience in the DEP, and interest and commitment of
                    the enlistee to be strong predictors of voluntary DEP
                    accession of separation.

Publications: R. A. Zimmerman, D. C. Zimmerman and M. E. Lathrop,
                "Study of Factors Related to Army Delayed Entry
                Program Attrition," Report NO. USAREC SR 85-3, Fort
                Sheridan, Illinois, October 1985.

                D. C. Zimmerman, R. A. Zimmerman and M. E. Lathrop,
                "Partial Test of a Model of Attrition from the Army's
                Delayed Entry Program," NPS Technical Report, in
                progress.

Conference   R. A. Zimmerman, D. C. Zimmerman, "Summary of Findings
Presentation: on the Development and Validation of Preenlistment
                Screening Composites for Army Enlisted Personnel,"
                paper presented at the Army Recruiting Research
                Coordination Conference, Northbrook, Illinois, October
                1985.

DEPARTMENT

OF

OPERATIONS RESEARCH

DEPARTMENT OF OPERATIONS RESEARCH

Sponsored research conducted by members of the Department of Operations Research (OR) spans a wide range of topics, consistent with the multi-disciplinary nature of the OR field. Specialization areas include optimization, stochastic models, statistics, simulation and modeling. Applications of work in these areas include reliability, mathematical programming, search, stochastic modeling, data analysis, statistics, ASW and AAW modeling, inventory, manpower modeling and simulation models.

MATHEMATICAL PROGRAMMING

Professors G. G. Brown and G. H. Bradley (Computer Science Department) have continued their work on large-scale optimization. Their current work involves development of specialized algorithms which exploit the structure in large mixed integer models arising in certain applications. Brown and Bradley have tested their methods on various applications, including scheduling ocean transportation of crude oil, real time dispatch of petroleum tank trucks and scheduling of Atlantic Fleet Naval Combatants.

Professor Brown has also collaborated with Professor R. K. Wood, together with Professor R. D. McBride at the University of Southern California, in analyzing properties of a variant of the projective linear programming algorithm. These researchers are currently working on ways of speeding up the solution of medium-scale problems using the algorithm they have developed.

Professor R. E. Rosenthal has been developing efficient solution methodologies for very large-scale multicommodity network optimization problems. Such problems are important in civilian and military logistics applications. Professor Rosenthal is also working with the Navy Personnel Research and Development Center on constrained nonlinear optimization algorithms for fitting item response models for questions used in personnel testing.

STOCHASTIC MODELING, DATA ANALYSIS AND STATISTICS

Professor D. P. Gaver and P. A. Jacobs have developed new methods of statistical analysis and probability modeling for solving problems arising in military and government applications. Empirical Bayes estimation procedures have been developed and studied for random parameter stochastic models arising in communications systems, reliability, failure rate and other point-process event rate data. This work has been supported by the Office of Naval Research. Professor Jacobs has also received National Science Foundation sponsorship for work on approximations to distributions arising in probabilistic models for computer systems.

Professor H. Larson and T. Jayachandran (Mathematics Department) have continued their work on oil analysis procedures, supported by Kelly Air Force Base. This research is directed toward improving the performance of the Joint Oil Analysis Program on on-condition-maintenance of aircraft engines and other equipment. These researchers have also been funded by the Naval Air Engineering Center to develop a test plan for evaluating the Portable Wear Metal Analyzers and they are currently preparing a report on the results of the test.

Professor R. Read is conducting research for the Naval Undersea Weapons Engineering Station, developing methods of identifying arrays whose location and orientation have changed. The methods use crossover data to estimate location and orientation corrections for one array relative to another.

Professor D. Barr is working on an ongoing project aimed at explaining the target acquisition process and factors that affect times to detection in multiple target scenarios. An analysis of data in the Thermal Pinpoint Data Base has provided insights into the characteristics models of multiple target acquistion should exhibit. This work has been sponsored by the U.S. Army Tradoc Systems Analysis Activity.

SIMULATION AND MODELING

Professor S. H. Parry, J. K. Hartman (deceased) and A. L. Schoenstadt (Mathematics Department) have been working on simulation and wargaming methodology for interdiction, under sponsorship of the U.S. Army Tradoc Operations Research Activity. The second year of research focused on network implementation, force deployment algorithms and a generalized value system. The goal of this continuing research program is to develop a model for battle which is two-sided, force-on-force at the Blue Corps, Red Front level.

Professor E. B. Rockower has been investigating several High Energy Laser (HEL) Propagation simulations, for suitability for use in studies of the Army battlefield environment. One result of this work, which is sponsored by the U.S. Army TRADOC Operations Research Activity, is the identification of the circular aperture assumption as a significant shortcoming of current HEL models.

RELIABILITY

Professors J. D. Esary and R. N. Forrest have worked, under Naval Undersea Warfare Engineering Station sponsorship, on performance and reliability of the Mk46 and MA50 torpedoes. Together with several thesis students, they have explored issues pertaining to multiple launches against a target.

Professor R. K. Wood has conducted research on evaluation of the reliability of binary systems, with support from the National Science Foundation. One result of this work has been the implementation of a partitioning and decomposition algorithm for evaluating fault trees which represent the reliability of binary systems.

ANTI-SUBMARINE WARFARE AND ANTI-AIR WARFARE MODELING

Professors J. N. Eagle and N. R. Forrest have been working on an ASW modeling project for the Naval War College (NWC) in support of wargame development at NWC. This research concerns improvement in the detection process model currently used by NWC and in developing ways to estimate the probability that a moving target will encounter a stationary sensor by time t.

Professors A. F. Andrus and R. Shudde have sponsorship by the Director of Tactical Readiness CNO OP-953 to install current software in the Fleet Mission Program Library Laboratory at the Naval Postgraduate School and to validate the anti-air warfare models in the library. Professor Andrus also developed a plan for specifying and evaluating contractor support technical requirements, under Navy Tactical Support Activity sponsorship. This research was provided on site at the Navy Tactical Support Activity in White Oak, MD.

INVENTORY AND PROCUREMENT

Professors F. R. Richards and A. W. McMasters have been working on an on-going research effort to developed improved wholesale inventory models for the U.S. Navy. This has resulted in a model for determining minimum investment levels needed to attain a specified Mean Supply Response Time goal while being subject to procurement and repair budget constraints. This work was sponsored by the Naval Fleet Material Support Office. Professor McMasters has also had Naval Electronics Systems Command support for continuing research on the question of when inventory management of an item should be transferred from NAVELEX to SPCC.

Professors D. C. Boger and S. S. Liao (Administrative Sciences Department) have conducted research on alternative quantity-split procedures and assessing nonrecurrent cost estimation procedures under a competitive procurement environment. Several methods for quantity-split were analyzed using data from the Sparrow Missile Program.

SEARCH

Professor A. F. Andrus has developed a model for computing the cumulative probability of detecting an evading target as a function of time for a discrete searcher. Professors J. N. Eagle and J. R. Yee have developed an easily implemented approximate solution procedure for the constrained search path, moving target search problem. The procedure determines a sequence of search cells which minimizes the probability of not detecting the target in a fixed number of time periods. Professor Eagle's work was sponsored by the Office of Naval Research (NPS Foundation Program).

MANPOWER MODELING

Professor P. R. Milch had sponsorship of the U.S. Navy Office of the Deputy Chief of Naval Operations for work on Naval Officer Corps Management. This work included development of a network flow model representing Surface Warfare Officer (SWO) career paths. This network representation was implemented on an IBM PC, to provide the SWO community manager with a tool for evaluating the feasibility and effects of alterations in career paths.

Professor R. Read has conducted research on the efficiency of the James-Stein, and other shrinkage estimators, for forecasting the attrition loss rates used in Marine Corps Manpower Planning Models. He has shown there can be dramatic improvement in forecasting attrition rates using these estimators, as compared to the empirical rates currently used. This research has been sponsored by the U.S. Marine Corps Headquarters.
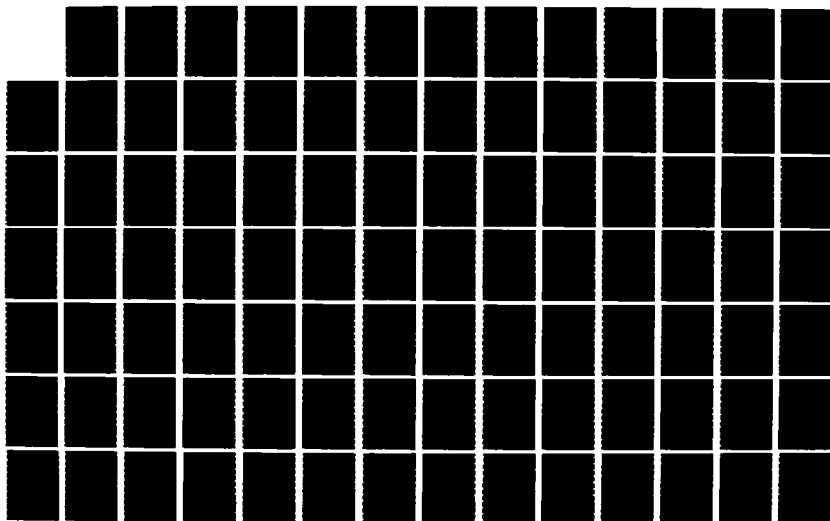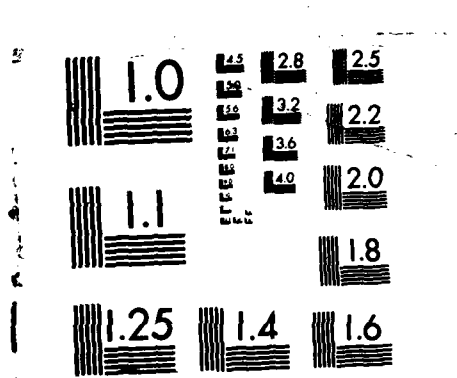
MICROCOPY RESOLUTION TEST CHART

SOVIET MILITARY OPERATIONS RESEARCH

Professor J. G. Taylor has carried out an investigation of Soviet cybernetic concepts (roughly corresponding to American C^3) underlying the design and operation of the Soviet automated troop control system. Professor Taylor examined Soviet open literature sources to develop the probable Soviet concept of control and the role by cybernetics in such work. A major conclusion is that Soviet control of technological and social processes, including the waging of war, can be understood in the cybernetics framework. This work was sponsored by the U.S. Air Force Systems Command.

HUMAN FACTORS

Professor G.K. Poock has been doing research with students on the feasibility of using recent technology for examining the retinal blood vessel pattern of the human eye as a personal identification device or measure. Professor Poock is examining the potential of this approach for controlling access to computers. It is a natural complement to his speech recognition research, which has been on-going for several years.

Professors D.E. Neil and C.W. Hutchins have been working on the interrelationships among human factors parameters impacting on air combat performance. This work has been sponsored by the Naval Training Equipment Center.

Title:	Fleet Mission Program Library Validation
Investigator(s):	A. F. Andrus, Associate Professor of Operations Research
	Rex Shudde, Associate Professor of Operations Research
Sponsor:	Director of Tactical Readiness CNO-OP-953
Objective:	Install current software in the Fleet Mission Program Library Laboratory and begin validation of Anti-Air-Warfare models.

| Summary: | The Fleet Mission Program Library Laboratory was augmented with the Navy tactical standard desk top computer, HP-9020, and the Integrated Battle Group Tactical Decision Aid software. The software and computer were made available for student and faculty instructional and research efforts. And evaluation of CAST, the computer aided Combat Air Patrol stationing plan was begun. The spherical earth calculations and the probabilities of aircraft engagement were evaluated. Errors in contractor supplied documentation were identified. |

Publications: A. F. Andrus and R. Shudde, Computer Aided Stationing Tool (CAST) Preliminary Technical Evaluation, NPS Technical Report, NPS55-85-027, October 1985.

Theses Directed: 1. J. J. Phelan, "A Review of ASW Models for the Integrated Tactical Decision Aid (ITDA)", Master's Thesis, March 1985.

2. "F. Barret, "FASTS: A Radar Simulation Model for the Development and Analysis of Aircraft Anti-Ship Tactics", Master's Thesis, March 1985; (Second Reader).

Title: IBM-PC Software Applications

Investigator(s):   A. F. Andrus, Associate Professor of Operations Research

Sponsor: Unsponsored

Objective: Develop IBM-PC software to augment instructional and
                     research activities.

Summary: A computer program, documentation and user's manual were
                     developed to facilitate plotting functions and line graphs
                     on the IBM-7371 and 7372 color plotters. The program is
                     available for use in the IBM-PC Laboratory in the
                     Department of Operations Research.

Publications: A. F. Andrus, "Function Plotting Software for the IBM-PC
                     and IBM-7371/7372 Plotters", NPS Technical Report,
                     NPS55-85-029, November 1985.

Title: Search Model Simulation and Development

Investigator(s):   A. F. Andrus, Associate Professor of Operations Research

Sponsor: Unsponsored

Objective: Develop computer simulation models of search scenarios
                    for instructional and research interests.

Summary: A computer model was developed for computing the
                    cumulative probability of detection as a function of time
                    for a searcher looking discretely for an evading target.
                    The model assumptions are: target detection is
                    deterministic; the target at predetermined search
                    points.

Publications: A. F. Andrus, "Stop and Look Detection Algorithm",
                    NPS Technical Report, NPS55-85-011, May 1985.

Title:	Tactical Development and Evaluation
Investigator(s):	A. F. Andrus, Associate Professor of Operations Research
Sponsor:	Navy Tactical Support Activity
Objective:	Provide plan for specifying and evaluating contractor support technical requirements; progress and results for the CNO Fleet Tactical Development and Evaluation Program.

Summary:

Research was provided on site at the Navy Tactical Support Activity, White Oak, Maryland during Quarter I, 1985. Research results were:

1. Established operational framework for specifying contract technical requirements for contractor support.

2. Established operational framework for evaluating contractor products and integrating results into tactical documentation.

3. Established all contract technical requirements for the conversion of existing hand held programmable calculator Fleet Mission Program Library software from the HP-67/97 to the Sharp PC-1500A programmable calculator.

4. Established all contract technical requirements for on-site contractor support for development of hand held programmable calculator Fleet Mission Program Library software.

Publications:

All reports were written for and delivered directly to the Director, Navy Tactical Support Activity. These reports included.

1. A. F. Andrus, Contract Technical Requirements for Analytical Support at COMSUBPAC for 1984-1987, Contract Request for Proposal Requirements, Navy Tactical Support Activity, 1984.

2. A. F. Andrus, Contract Technical Requirements for Software Development and Conversion for the Hand Held Computer Decision Aid Fleet Mission Program Library, Contract Request for Proposal Requirements, Navy Tactical Support Activity, 1984.

3. A. F. Andrus, Technical Management, Status, Direction and Plan for Hand Held Computer Tactical Decision Aid Fleet Mission Program Library, Management Report, Navy Tactical Support Activity, 1984.

Title: Target Acquisition Analysis

Investigator(s):   D. R. Barr, Professor of Operations Research

Sponsor: U.S. Army TRADOC System Analysis Activity

Objective: To analyze the Thermal Pinpoint Data Base as part of an
                    ongoing effort to examine target acquisition processes in
                    general.

Summary: Detection and acquisition of targets in a battlefield
                    involves a complex interaction of environmental, tactical,
                    hardware and human psychological and physiological
                    factors. Models currently used to generate target
                    acquisition events in combat simulations sometimes give
                    results which disagree with results from field and
                    laboratory experimentation. A recent experiment,
                    conducted at Fort Hunter-Ligget, played target detection by
                    tanks using various optical infared sensors and methods.
                    The data from this "Thermal Pinpoint" experiment were
                    analyzed to determine the effects of factors such as
                    range, target observer motion, in the target acquisition
                    process, as measured by times to detection and fractions
                    of targets detected. An analyzes of times within field of
                    view was initiated, using survival analysis techniques.
                    Early results indicated that "high value" targets survive
                    for significantly shorter periods than "low value"
                    targets, implying a detection discrimination filter is
                    applied by tank gunners.

Thesis Directed: C. McKenzie, "An Analysis of Target Acquisition Behavior
                    for Observers in Tanks Equipped with Thermal or Optical
                    Sighting Systems", Master's Thesis, September 1985

Title: Large-Scale Optimization

Investigator(s): G. G. Brown, Professor of Operations Research
G. H. Bradley, Professor of Computer Science

Sponsor: Office of Naval Research

Objective: Develop theory and algorithms for solution of large-scale optimization models

Summary: A continuing research effort emphasizing exploitation of special problem structure. Decomposition and relaxation methods are being developed and applied in concert with specialized algorithms to solve the subproblems produced. The main impetus of this work is provided by large mixed integer models arising in diverse contexts ranging from capital budgeting to refinery scheduling. Large nonlinear and network models are also addressed for electrical transmission systems, chemical equilibria problems, and the like. Special integer enumeration control structures are being developed which employ a novel elastic model formulation especially useful for difficult integer master problems generated by primal or dual decomposition schemes. A mathematical programming modeling system to allow direct execution of optimization models is being developed. Each major avenue of research is thoroughly tested on real-life problems provided by other researchers, government agencies and commerical sources.

Publications: G. Brown, R. McBride, and K. Wood "Extracting Embedded Generalized Networks from Linear Programming Problems," Mathematical Programming, 32, 1985, pp. 11-31.

G. Brown, G. Graves, and M. Honczarenko, "Design and Operation of a Multicommodity Production/Distribution System Using Primal Goal Decomposition," Management Science, forthcoming.

G. Brown and R. McBride, "Solving Generalized Network Problems," Management Science, 30, 1984, pp. 1497-1523.

G. Brown and B. Shubert, "On Random Binary Trees," Mathematics of Operations Research, 9, 1984, pp. 43-65.

G. Brown, G. Graves and D. Ronen, "Scheduling Ocean Transportation at Crude Oil," Management Science, in submission.

G. Brown and G. Graves, "Real-Time Dispatch of Petroleum Tank Trucks," Interfaces, forthcoming.

G. Brown and W. Wright, "Automatic Identification of Embedded Network Rows in Large-Scale Optimization Models," Mathematical Programming, 29, 1984, pp. 41-56.

Conference Presentation:	G. Brown, "Set Partitioning Applied To Optimizing Fleet Activities," Pennsylvania State University Lecture Program, State College, Pennsylvania, February 15, 1985.

G. Brown, "Scheduling Ocean Transportation of Crude Oil," Stanford University Colloquium, Palo Alto, California, March 6, 1985.

G. Brown and C. Ellis, "Real-Time, Wide Area Dispatch of Petroleum Tank Trucks," CPMS Summer Workshop, Golden, Colorado, July 29, 1985.

G. Brown, L. Dewald, and K. Wood "Network Specialization of Non-Cycling Primal Simplex Methods," ORSA/TIMS, Boston, Massachusetts, April 30, 1985.

G. Brown, C. Goodman, and K. Wood, "Annual Scheduling of Atlantic Fleet Naval Combatants," 12th International Symposium on Mathematical Programming, Boston, Massachusetts, August 6, 1985.

G. Bradley and R. Clemence, "Implementation of a Structured Modeling Language for Optimization", 12th International Symposium on Mathematical Programming, Boston, Massachusetts, August 7, 1985.

G. Bradley and R. Clemence, "Implementation of Structured Modeling For Optimization," TIMS/ORSA, Dallas, Texas, November 27, 1984.

G. Brown, "Mathematical Programming Systems --- Where Do We Go From Here?" panel presentation TIMS/ORSA, Dallas, Texas, November 27, 1984.

G. Brown, R. Rosenthal and C. Staniec, "Shipment Planning with Multi-Commodity Optimization," TIMS/ORSA, Dallas, Texas, November 28, 1984.

G. Bradley and R. Clemence, "Structured Modeling for Optimization," American Institute of Chemical Engineers, San Francisco, November 19, 1984.

Theses Directed:	C. Goodman, "Annual Scheduling of Atlantic Fleet Naval Combatants" Master's Thesis, March 1984

G. Breitschnieder, "Solving Linear Programs with the Projective Algorithm, Master's Thesis, September 1985

P. Dorin, "How Cognitive Processes Aid Program Understanding", Master's Thesis, June 1985

C. Murnan, "Reusable Software: Trade-off Analysis and a New Approach", Master's Thesis, June 1985

Title: A Study of the Projective Algorithm for Linear
                    Programming

Investigator(s):   G. G. Brown, Professor of Operations Research and
                    R. K. Wood, Assistant Professor of Operations Research

Sponsor: NPS Foundation Research Program

Objective: To develop and analyze a prototypic projective linear
                    programming algorithm

Summary: This work has been conducted jointly with Professor R. D.
                    McBride at the University of Southern California. A
                    algorithmic barrier function variant of the projective
                    linear programming algorithm has been implemented and
                    tested. Testing on medium - scale problems has verified
                    controversial claims of low iteration counts. However,
                    total solution times are long since solution of the
                    symmetric linear system of equations at each iteration is
                    difficult. Current research efforts are directed at
                    speeding up these solutions using an incomplete Cholesky
                    factorization with iterative improvements.

Conference   R. K. Wood, "Implementing the Projective Linear
Presentations: Programming Algorithm ", ORSA/TIMS Joint National
                    Meeting, Boston, Massachusetts, April 29 -May 1, 1985.

                    G. G. Brown, R. D. McBride and R. K. Wood, "Computational
                    Methods in the Projective Linear Programming Algorithm,
                    "ORSA/TIMS Joint National Meeting, Atlanta, Georgia
                    November 4-6, 1985.

Thesis Directed: G. W. Bretschneider, "An Implementation of The
                    Projective Algorithm for Linear Programming," Master's
                    Thesis, September 1985

Title:	An Approximate Solution Technique for the Constrained Search Path Moving Target Search Problem
Investigator(s):	J. N. Eagle, Associate Professor of Operations Research J. R. Yee, Adjunct Professor of Operations Research
Sponsor:	NPS Research Foundation Program (for J. N. Eagle only)
Objective:	To develop an easily implemented approximate solution procedure for the constrained search path moving target search problem.

Summary:	A search is conducted for a target moving in discrete time among a finite number of cells according to a known Markov process. The searcher must choose one cell in which to search in each time period. The set of cells from which he can choose is a function of the cell chosen in the previous time period. The problem is to find a searcher path, i.e., a sequence of search cells, that minimizes the probability of not detecting the target in a fixed number of time periods. The problem is formulated as a nonlinear program and solved for a local optimum by a simple implementation of the convex simplex method.

Publications:	J. N. Eagle and J. R. Yee, "An Approximate Solution Technique for the Constrained Search Path Moving Target Search Problem," NPS Technical Report NPS55-85-015, October 1985.
Thesis Directed:	M. Segal, "Two New Approximate Solution Techniques for a Moving Target Problem when Searcher Motion is Constrained", Master's Thesis, September 1985

Title:	ASW Modelling
Investigator(s):	J. N. Eagle, Associate Professor of Operations Research
	N. R. Forrest, Professor of Operations Research
Sponsor:	Naval War College
Objective:	To support seminar wargame development for the Naval War College.

Summary: Professor Forrest's research: An evaluation is made of three passive acoustic detection models and a replacement model suggested for use in the Naval Warfare Gaming System (NWGS). The replacement model is an integration time model, which appears to more closely describe the detection process than does the simplier threshold crossing model currently used in NWGS.

Professor Eagle's research: The problem addressed is that of estimating the probability of a moving target encountering a stationary sensor by time t. The target follows a Brownian motion path and is constrained to remain within a square region A. The detecting sensor is fixed at the center of A. Two expressions for this probability are given. The first results from an approximation to the exact solution of the diffusion equation and the second from experimentation with a Monte Carlo simulation of the Brownian motion process.

Applications include estimating the rate at which randomly moving targets will encounter objects such as fixed acoustic arrays, sonobuoys, or insect traps (if the target is, say, a fruit fly).

Publications: R. N. Forrest, "Passive Acoustic Detection Models and the Naval Warfare Gaming System", NPS Technical Report NPS55-85-007, April 1985.

J. N. Eagle, "Estimating the Probability of a Diffusing Target Encountering a Stationary Sensor", NPS Technical Report NPS55-85-013, July 1985.

Thesis Directed: M. Sislioglu, "A Mathematical Model for Calculating Detection Probability of a Diffusion Target", Master's Thesis, September 1984

Title: Performance and Reliability Studies

Investigator(s):   J. D. Esary, Professor of Operations Research
                        R. N. Forrest, Professor of Operations Research and
                        Chairman, ASW Academic Group

Sponsor: Naval Undersea Warfare Engineering Station

Objective: To explore issues related to torpedo performance and
                        reliability, in particular certain aspects of dual
                        launces against a target.

Summary: A thesis by W. J. Walsh, presents a study of an alternate
                        water entry tactic for an Mk 46 torpedo, based on a
                        simulation model which was validated against established
                        simulations and then varied to incorporate the alternate
                        tactic.

                        A thesis by W. M. Morrison, is a distillation of
                        information about the Mk 50 torpedo gathered from sources
                        at NUWES and elsewhere, designed to help the potential
                        user community understand the weapon.

                        Among several "torpedo" theses completed during FY86 by
                        Antisubmarine Warfare and Operations Research students,
                        another by R. D. Harrelson, examines the potential for
                        interference between Mk 50 and Mk 46 torpedoes, and
                        suggests consideration of certain parallel launch tactics
                        using one of each type.

Theses Directed: R. D. Harrelson, "The Potential for Mutual Interference
                        between the Mk 50 and Mk 46 Torpedoes (U)", September
                        1985, (SECRET).

                        W. M. Morrison, "An Overview of the Mk 50 Torpedo from a
                        User's Point of View (U)", September 1985, (SECRET).

                        W. J. Walsh, "A Model to Compare the Probabilities of Hit
                        for the Depth Against the Present Powered Dive to Search
                        Depth (U)", March 1985, (SECRET).

Publications: R. N. Forrest, "A Dual Launch Torpedo Effectiveness
                        Estimation Method", NPS Technical Report NPS55-85-022,
                        September 1985.

Title: Stochastic Modeling and Data Analysis

Investigator(s):   D. G. Gaver, Professor of Operations Research
                    P. A. Jacobs, Associate Professor of Operations Research

Sponsor: Office of Naval Research

Objective: To develop, apply and test and validate new methods of
                    statistical data analysis and probability modeling for
                    solving problems arising in applications, with special
                    reference to problems in the Navy, and the government and
                    military in general.

Summary: Estimation procedures have been developed and studied for
                    random parameter stochastic models arising in reliability,
                    failure rate, or other point-process event rate data.
                    These empirical Bayes procedures estimate the individual
                    event rate by data-directed poolings of similar rates but
                    do so in a "discrepancy-tolerant" fashion akin to the
                    behavior of modern robust statistics. The "calibration
                    problem" has been studied in the context of the estimation
                    of surface wind speed by remote sensing of white cap cover.
                    Approximations to distributions arising in probability
                    models for computer systems and reliability were proposed
                    and evaluated. Numerical procedures for computing first
                    passage times in Markov chains were developed. A model for
                    resource conflict resolution in a communications system
                    model was proposed and studied.

Publications: G. Latouche, P. A. Jacobs and D. P. Gaver, "Finite Markov
                    Chain Models Skip-Free in One Direction," Naval Research
                    Logistics Quarterly 31 (1984), pp. 571-588.

                    D. P. Gaver, P. A. Jacobs, and G. Latouche, "Finite Birth
                    and Death Models in Randomly Changing Environments," Adv.
                    Appl. Prob. 16 (1984), pp. 715-731.

                    D. P. Gaver and M. Mazumdar, "On the Computation of Power-
                    Generating System Reliability Indexes," Technometrics 26
                    (1984), pp. 173-185.

                    P. A. Jacobs, "First Passage Times for Combinations of
                    Random Loads," Naval Postgraduate School Technical Report,
                    NPS55-85-002, February 1985.

                    P. A. Jacobs, "First Passage Times for Combinations of
                    Random Loads," S.I.A.M. Journal Applied Mathematics
                    (forthcoming)

                    D. P. Gaver and P. A. Jacobs, "Processor-Shared
                    Time-Sharing Models in Heavy Traffic," Naval Postgraduate
                    School Technical Report, NPS55-85-004, March 1985.

Publications: D. P. Gaver and P. A. Jacobs, "Processor-Shared
(continued)   Time-Sharing Models in Heavy Traffic," S.I.A.M. Journal on
                     Computing (forthcoming)

                     D. P. Gaver and J. P. Lehoczky, "Random Parameter Markov
                     Population Process Models and Their Likelihood, Bayes, and
                     Empirical Bayes Analyses," Naval Postgraduate School
                     Technical Report, NPS55-85-020, September 1985.

                     D. P. Gaver and J. P. Lehoczky, "Random Parameter Markov
                     Population Process Models and Their Likelihood, Bayes, and
                     Empirical Bayes Analyses," Herbert Solomon Anniversary
                     Volume (forthcoming)

                     D. P. Gaver, "Discrepancy-Tolerant Hierarchical Poisson
                     Event-Rate Analysis", Naval Postgraduate School Technical
                     Report, NPS55-85-016, July 1985.

                     I. G. O'Muircheartaigh and D. P. Gaver, "Estimation of Sea
                     Surface Wind Speed from White Cap Cover: Statistical
                     Approaches Compared Empirically and by Simulation," Naval
                     Postgraduate School Technical Report, NPS55-85-021,
                     September 1985.

Conference
Presentations: D. P. Gaver and P. A. Jacobs, "Two Type Processor Sharing
                     Delays," ORSA/TIMS Joint National Meeting, Dallas,
                     November, 1984.

                     D. P. Gaver and G. Fayolle, "A Resource Conflict Resolution
                     Problem," TIMS/ORSA Joint National Meeting, Boston, April
                     1985.

                     D. P. Gaver, "Discrepancy-Tolerant Random Parameter Models
                     Via Sculptured Normal Distributions," 19th Actuarial
                     Research Conference; Credibility Theory and Bayesian
                     Approximation Methods, University of California, Berkeley,
                     October 1984.

                     D. P. Gaver, P. A. Jacobs and J. Lehoczky, "Random
                     Parameter Stochastic Processes: Some Models and Inference
                     Problems," Third TIMS/ORSA Special Interest Conference on
                     Applied Provability. Statistical and Computational Problems
                     in Probability Modeling. Williamsburg, January 1985.

Title: Stochastic Modelling and Data Analysis

Investigator(s):   P. A. Jacobs

Sponsor: National Science Foundation

Objective: To develop and study probabilistic models

Summary: Approximations to distributions arising in probabilistic
                        models for computer systems and reliability are proposed
                        and evaluated. Gaussian approximations to the
                        distribution of response time of a job in a
                        processor-shared computer system model are developed.
                        Exponential approximations to the distribution until a
                        combination of random loads first exceeds the strength of
                        a structure are put forth and studied.

Publications: P. A. Jacobs, First Passage Time for Combinations of
                        Random Loads. NPS Technical Report NPS55-85-002,
                        February 1985.

                        D. P. Gaver and P. A. Jacobs, Processor-Shared
                        Time-Sharing Models in Heavy Traffic, NPS
                        Technical Report NPS55-85-004, March 1985.

Conference   D. P. Gaver and P. A. Jacobs, Two-Type Processor Sharing
Presentations: Delays. Joint National Meeting ORSA/TIMS, Dallas, Texas,
                        November 1984.

Title: Field Test of the Portable Wear Metal Analyzer (PWMA)

Investigator(s):   H. Larson, Professor of Operations Research
                    T. Jayachandran, Professor of Operations Research

Sponsor: Naval Air Engineering Center

Objective: Assist the development of a test plan to evaluate the
                    PWMA in operational conditions and to analyze the data
                    collected.

Summary: A test plan was developed and implemented at 4 sites (at
                    some better than others). The data collected has been
                    subjected to a number of analyses (coded here in APL) and
                    several preliminary reports have been issued. A final
                    technical report will be issued at the inclusion of the
                    evaluation.

Title: Oil Analysis Procedures

Investigator(s): H. Larson, Professor of Operations Research
                  T. Jayachardran, Professor of Mathematics

Sponsor: Kelly Air Force Base

Objective: To support and enhance the performance of the Joint Oil
                  Analysis Program in On-Condition-Maintenance of aircraft
                  engines and other equipment.

Summary: Our contributions this year to this ongoing project
                  include the final checking of our statistical algorithm
                  for CEMS IV including the removal or earlier program
                  bugs, and review of its implementation on the Z-100
                  microcomputer. We provided technical consultation for
                  the development of software to automate the spectrometer
                  daily calibration and are monitoring the data collected
                  for laboratory certification. We have begun the initial
                  investigation into relating the readings produced by the
                  old stationary atomic emission spectrometer with those
                  produced by the new portable atomic furnace instrument.

Title: Stock Coordination Management between NAVELEX and SPCC

Investigator(s): A. W. McMasters, Associate Professor of Operations
                  Research and Administrative Sciences

Sponsor: Naval Electronics Systems Command

Objective: This is a continuing research effort addressing the
                 question of when inventory management of an item should
                 be transferred from NAVELEX to SPCC.

Summary: The problem of stock coordination between NAVELEX and
                 SPCC became more complex this year because of the stock
                 funding of depot level repairables. Any items which are
                 now transferred to SPCC to manage must be approved by DOD
                 based on their impact on the stock fund. 2Z cog items
                 managed by NAVELEX are not stock funded and are free to
                 the customer. After transfer to SPCC they become 7H cog
                 and the customer must buy them out of his OPTAR. As a
                 consequence, stock coordination has been temporarily
                 halted until a methodology can be developed for
                 forecasting the needed increase in stock funds and
                 incorporating those forecasts in the POM process. The
                 research conducted this year concentrated on ways to
                 increase DOD funding support by 2Z cog spares for those
                 items experiencing random demands. The major conclusions
                 were that NAVCOMPT policy should recognize that some 2Z
                 items do indeed experience random demand and provide the
                 procurement and repair funds so that the fleet is better
                 able to operate. NAVELEX should take advantage of the
                 new Total Carcass Tracking System program so that the 2Z
                 carcass loss rates can be reduced since replenishment
                 procurements are not currently being funded.

Thesis Directed: R. R. and L. J. Bird, "An Analysis of the Advice Codes
                  and Priorities Placed on 2Z Cognizance Requisitions",
                  Master's Thesis, December 1984.

Title	Naval Officer Corps Management Studies

Investigator(s):   P. R. Milch, Professor of Operations Research

Sponsor: Director, Military Personnel Policy Division
Office of the Deputy Chief of Naval Operations,
Department of the Navy, OP-13 and OP-91

Objective: (a) To critically review current officer career paths in the Surface Warfare, the Aviation Warfare and the Nurse Corps communities with special regard to permanent change of station (PCS) moves.

(b) To determine the best methodology for measuring and evaluating the effectiveness of recent changes to the Surface Warfare Officer (SWO) career path.

(c) To initiate work toward development of a network flow model representing SWO career paths with the ultimate goal of providing community managers with a tool to make rapid assessment of likely future consequences of proposed changes in the career paths of SWO's.

Summary: (a) Network representation of career paths within the Surface Warfare, Aviation Warfare and Nurse Corps Communities were developed and related to PCS moves. Geographic and historical billet analyses were conducted in order to examine possible alterations in tour sequences and, thereby, reduce the number of PCS moves. Other PCS related topics specific to each of the above three communities were also examined. Some alternatives to the career paths were recommended in each community.

(b) This topic was investigated by Dr. R. F. Morrison of the Navy Personnel Research and Development Center, San Diego, California.

(c) Based on a network representation of all significant career paths in the SWO community, completed previously, an interactive computer model was developed in the Turbo Pascal language for use on an IBM PC (or compatible). The purpose of the model is to provide the SWO community manager with a tool to simulate alterations in the career paths of the whole or a segment of the SWO community and evaluate both the feasibility of such changes and their potential for achieving desirable improvements, e.g. an increase/decrease in command opportunity or reduction in PCS moves.

Title: Airland Research Model

Investigator(s):   S. H. Parry, Professor of Operations Research
                      J. K. Hartman, Professor of Operations Research
                      A. L. Schoenstadt, Professor of Operations Research

Sponsor: U. S. Army TRADOC Operations Research Activity

Objective: To develop a model with the following characteristics:

                      (a) A two-sided, force-on-force model at the Blue Corps,
                      Red Front level.

                      (b) A primarily systemic (no human intervention) decision
                      architecture, but with the provision to selectively
                      insert human decision-makers if required for the
                      development of rule-based systems.

                      (c) A generalizd network methodology and multidimensional
                      coordinate system to represent transportation systems,
                      terrain, communication links, and both fixed and mobile
                      combat assets.

                      (d) A resolution determined by the function and situation
                      being modeled.

                      (e) An ability to represent planning based on future-time
                      extrapolation of the possible results of plan execution.

                      (f) Detailed audit trails of cause/effect relationships
                      between decisions made and the results of decision
                      executions.

Summary: The initial year of research was summarized in the 1983-84
                      Research Activities under the title "Research in
                      Simulation/Wargaming Methodology for Interdiction." This
                      second year research focused network implementation, force
                      deployment algorithms, and the generalized value system.
                      In addition, development of the Fire Support module was
                      initiated, and development of the Maintenance/Recovery,
                      Engineer and Troop Control Planning modules was continued.
                      Initial r̶ ̶ch efforts were completed to implement the
                      transportatiu. network, and the allocation of maneuver
                      units and countermobility assets to the network by Major
                      Dean Craig. This implementation was based on methodologies
                      developed in References 1, 2, and 4 under Theses Directed.
                      A network was constructed to represent a brigade sized
                      maneuver area in the Fulda region of FRG. The network
                      represents a 20 by 80 KM area and consists of approximately
                      500 nodes and 2500 arcs. Algorithms to allocate maneuver
                      forces and countermobility assets were implemented on the

Summary
(continued)

network. These algorithms are based on finding minimum
paths through the network which are considered to describe
probable axes of advance by enemy forces. The search for
minimum path is particularly suited to a network structure
and many algorithms currently exist for this purpose. Once
the minimum path is located, combat units and
countermobility obstacles are deployed on the arcs of the
path to (hopefully) increase the travel time of enemy units
along these arcs. Then a new minimum path is determined and
further combat resources are placed along the arcs of the
new path. This process continues until all combat resources
(within specified constraints) have been allocated. A
Generalized Value System (GVS) is required in the Airland
Research Model to provide a common basis for assigning
values to a variety of battlefield assets. The GVS must
both describe the current situation and provide for the
determination of future actions. Algorithms are being
developed that produce rank-orderings and target priority
lists for enemy units and assest; and that allocate
maneuver, fire support interdiction and other assets against
the targets on the lost. At the heart of such a
quantitative optimization algorithms would, of necessity,
lie a generalized value system (GVS), i.e. a system capable
of assigning a "value" to each candidate target for the
list. Research to date has produced an initial axiomatic
generalized value system for Airland Research Model. The
advantage of an axiomatic system is that the values of all
potential targets are derived from some basic set of
principles. Therefore ad-hoc assignments are unnecessary,
and comparisons between unlike systems are consistent. The
values provided by this proposed axiomatic value system
forms the basis for target allocation decisions.

Publications: "Toward an Axiomatic Generalized Value System", Hartman, J.,
                       Parry, S., & Schoenstadt, A., NPS Technical Report TBP.,
                       December, 1985.

Conference
Presentations: "Generalized Value System for the Airland Research
                       Model," Parry, S., 53rd MORS, U.S. Air Force Academy,
                       Colorado Springs, Co., June, 1985.

                       "The Air/Land Wargame, "Parry, S., & Schoenstadt, A.,
                       NPS/CEMA Conference on Combat Modeling, Naval Postgraduate
                       School, May 2-3, 1985.

Theses Directed: 1. "Combat Engineer Allocation Model", Kazimer, R.V., MS
                           in Operations Research, December, 1984.

                       2. "Network Representation for Combat Models",
                           Krupenevich, T.P., MS in Operations Research,
                           December, 1984.

Theses Directed: 3. A Maintenance Support Model", Peterson, S.P., MS in
(continued)   Operations Research, December, 1984.

                     4. "Methodologies of Direct Fire Allocation and Maneuver
                         Unit Allocation and Placement", Boyd, K., MS in
                         Systems Technology (C3), March, 1985.

                     5. "A Model for Planning of Maneuver Unit and Engineer
                         Asset Placement", Craig, D.E., MS in Operations
                         Research, September, 1985.

Title: Attrition Rate Generation for Manpower Models

Investigator(s): R. R. Read, Professor Operations Research

Sponsor: U. S. Marine Corps, Headquarters, MPI 40

Objective: To explore the efficency of the James-Stein and other shrinkage type estimators for forecasting the numerous and various attrition loss rates that appear in the Marine Corps Manpower Planning Models.

Summary: The class of James-Stein estimators can be applied in a variety of ways. We have identified the following steps: i) The aggregation of cells into groups whose attrition behavior should be internally homogenous. ii) The application of a variance stabilizing transformation to the empirical rates of each group. iii) The estimation of the shrinkage parameters for each group. iv) The application of the shrinkage technique. V) The inversion of the transform to return to the original scale.

The efficacy of a candidate technique is measured using a sum of squares deviation of forecast rates from recent year actuals. The validation procedure is applied to the transformed quantities as well as to the rates in the original scale. In the somewhat limited calculations performed thus far, the results are rather dramatic. The improvement shown by the technique (compared to the use of historical empirical rates) has always been at least a factor of two, and often as high as a factor of ten.

Theses Directed: D. D. Tucker, "Loss Rate Estimation in Marine Corps Manpower Officer Manpower Models," NPS Master's Thesis, September 1985

H. Amin Elseramegy, "CART Program: Implementation on the IBM 3033 and Application to Marine Corps Manpower Data," Master's Thesis, December 1985

Title: Calibration Control of a System of Sonar Arrays

Investigator(s):   R. R. Read, Professor of Operations Research

Sponsor: Naval Undersea Weapons Engineering Station

Objective: To develop a crossover data analysis methodology that
                    will identify arrays whose location and orientation may
                    have changed since the last calibration survey. To
                    develop decision rules for choosing among the several
                    possible actions when tracking "mismatches" occur.

Summary: The previously developed methodology for using crossover
                    data to estimate location and orientation corrections of
                    one array relative to another has been extended to the
                    multiple array setting. Algorithms and computer software
                    have been developed to calculate these corrections for
                    the various sensor stations in a given problem. The
                    programs have been written in a general (transportable)
                    Fortran 77 and have been delivered to the sponsor in
                    floppy disk form.

                    G. Gygax, as part of his Master's Thesis, has
                    developed a realistic simulation model that can be used
                    to generate reference distributions for use in the
                    development of the decision rules. This work won this
                    year's MORS (Military Operations Research Society)
                    graduate research award.

Publications: R. R. Read, "Program for the Simultaneous Estimation of
                    Displacement and Orientation Corrections for Several
                    Short Base Line Arrays" NPS Technical Report,
                    NPS55-85-028, November 1985.

Thesis Directed: G. Gygax, "The Simulation of Remotely Measured Paths of
                    Underwater Vehicles for the Purpose of Monitoring the
                    Calibration of Test Ranges," Master's Thesis,
                    September 1985

Title:	Structured Exit Interviews Using MDS
Investigator(s):	R. R. Read, Professor of Operations Research
Sponsor:	Unsponsored
Objective:	The exit interviews of graduating students provide an important opportunity to gather organized and timely information concerning the students' educational experience. These interviews need to be conducted in an objective manner, and care needs to be exercised to avoid perceptual bias on the part of the interviewer. The characteristics of instruction that are important vary from class to class and the dynamic identification of these characteristics is important.
Summary:	A technique of Multidimensional Scaling (MDS) has been selected and tested with the cooperation of two graduating classes in the Operations Analysis Curriculum. This technique provides a spatial representation of the instructors that served the specific graduating class and, with the help of multiple regression techniques, allows the identification of the important characteristics. Since some of these effects, e.g. how hard the instructor works the students, may be undesirable in terms of inclusion in an instructor scoring system it becomes feasible to remove these effect by projecting the output data into a subspace of lower dimension.
Summary (Cont'd):	Previous work has shown the most variable component in the SOF system is the student group involved. The present work allows the interviewer to focus on the idiosyncrasies of each class when viewing the students' perception of instruction. The current use of the SOF data is shown to lack stability as the students' ranking of instructors using SOF correlates only 50% with the ranking obtained during the exit interview.
Publications:	R. R. Read, "Structured Exit Interviews Using MDS," NPS Technical Report, NPS55-85-024, September 1985.
Thesis Directed:	J. F. McCourt, "Using Multidimensional Scaling to Describe Teacher Performance," Master's Thesis, March 1985

110

Title:	Resystemization Modelling Support
Investigators:	F. R. Richards, Associate Professor of Operations Research A. W. McMasters, Associate Professor of Operations Research and Administrative Sciences
Sponsor:	Naval Fleet Material Support Office
Objective:	This is a continuing research effort to develop improved wholesale inventory models for the U.S. Navy.

Summary:

The Mean Supply Response Time (MSRT) initial provisioning model developed two years ago and evaluated last year was officially accepted by the Navy (OP-41) for implementation in December 1984. Research efforts then turned towards developing a repairables replenishment model to complement the provisioning model. A formula was developed for determining the average annual mean supply response time for specified frequencies of procurement and repair. This formula showed that the minimum MSRT corresponds to procurement and repair quantities of one unit; any quantity larger causes additional delays. The formula was then used to develop a model for determining minimum investment levels needed to attain a specified MSRT goal while being subject to procurement and repair budget constraints. Analyses of this model is currently being conducted.

Theses Directed:

C. L. Apple, "A Systems Approach to Inventory Management of Repairables in the Navy," Master's Thesis, March 1985.

D. B. Wadsworth, "Application of METEOR to the Evaluation of Multi-Echelon Inventory Models," Master's Thesis, March 1985.

K. Y. Ko, "Comparison of the METRIC and Heuristic NPS Inventory Model," Master's Thesis, June 1985.

Title: Laser - Propagation - Code Study

Investigator(s):   E. B. Rockower, Adjunct Professor of Operations
                    Research

Sponsor: U. S. Army TRADOC Operations Research Activity

Objective: To evaluate a number of High Energy Laser (HEL)
                    Propagation codes for suitability in the Army battlefield
                    environment. Modify and improve where appropriate. This
                    is now a continuing effort at NPS.

Summary: A number of laser propagation codes developed for system
                    - analysis studies of HEL propagation within the
                    turbulent atmosphere were evaluated. The Army HELAWS
                    code was modified to run on the NPS 3033 mainframe
                    computer. A significant short coming of this and
                    virtually all other system analysis HEL codes was
                    identified. This is the (unrealistic) restriction to
                    circular aperture lasers. A new laser beam - Quality/
                    aperture - shape scaling relation was, therefore,
                    developed so that more realistic modeling of HEL's with
                    rectangular apertures could be performed with existing
                    codes.

Publications: E. Rockower, "A New Laser Beam - Quality/Aperture - Shape
                    Scaling Relation," submitted to Applied Optics

                    E. Rockower, "Laser Propagation Code Study," NPS
                    Technical Report, NPS55-85-019, September, 1985.

112

Title: Multicommodity Network Flow Optimization

Investigator(s):   R. E. Rosenthal, Associate Professor of Operations
                       Research

Sponsor: NPS Foundation Research Program

Objective: To develop efficient solution methodology for very large
                       scale multicommodity network optimization problems.

Summary: Multicommodity network flow optimization has long been
                       identified as an important problem area in civilian and
                       military logistics applications. An algorithm developed
                       by the investigator has achieved approximate solutions on
                       some to the largest problems of this type ever attempted.
                       These problems were based on data supplied by the Army
                       Armament, Munitions and Chemical Command.

Title: Solution of Nonlinear Optimization Problems Arising in
Psychometric Research

Investigator(s): R. E. Rosenthal, Associate Professor of Operations
Research

Sponsor: Navy Personnel Research and Development Center

Objective: To develop a constrained nonlinear optimization algorithm
for fitting polychotomous, undimensional item-response
models.

Summary: Polychotomous, undimensional item-response models were
developed recently at NPRDC. These are personnel testing
models, which keep the various incorrect responses to a
multiple-choice question distinct. When an examinee's
test is scored, these models allow one to use the pattern
of incorrect responses, as well as the pattern of correct
responses, in estimating the examinee's level of ability.
The price one pays for this added modeling power is the
need to estimate a much greater number of parameters than
is required in the usual, dichotomous models. This
research has identified nonlinear optimization algorithms
for performing this parameter estimation.

Title:	Reliability Evaluation of Binary Systems
Investigator(s):	R. K. Wood, Assistant Professor of Operations Research
Sponsor:	National Science Foundation
Objective:	To develop and implement new techniques for evaluating the reliability of binary systems represented as networks and fault trees.

Summary: Special state-space partitioning techniques together with topological reduction and decomposition schemes have been developed for computing K-terminal reliability in undirected networks. A general framework has been devised from which all partitioning algorithms may be viewed and evaluated. A partitioning and decomposition algorithm has been implemented for the evaluation of fault trees. The algorithm employs recursive partitioning and a variety of reduction and decomposition steps to minimize the enumeration required making it significantly more efficient than techniques based on cutset enumeration. The output of the algorithm is either the probability of the top event or a valid set of Pascal statements for repeated evaluation of the fault tree with different inputs.

Publications: R. K. Wood, "A Factoring Algorithm Using Polygon-to-Chain Reductions for Computing K-Terminal Network Reliability," Networks, Vol. 15, 1985, pp. 173-190.

R. K. Wood, "Factoring Algorithms for Computing K-Terminal Network Reliability," IEEE Transactions on Reliability, forthcoming.

W. T. McCullers and R. K. Wood, "Probabilistic Analysis of Fault Trees," in progress.

Conference Presentations: R. K. Wood, "Fault Tree Evaluation Without Cutsets," ORSA/TIMS Joint National Meeting, Boston, Massachusetts, April 29 - May 1, 1985.

Thesis Directed: W. T. McCullers, "Probabilistic Analysis of Fault Tree Using Pivotal Decomposition," Master's Thesis, September 1985

DEPARTMENT

OF

NATIONAL SECURITY AFFAIRS

National Security Affairs has adopted the innovative application of microcomputer technology to integrate automatic data processing into its multidisciplinary curricula, and initiated a student microcomputer pilot project employing the computer resources of the school and other effective efficient use. Our grist embraces the multiple areas of global political, socioeconomic, and technological concern, and the role of our armed forces in that ambience to promote and sustain U.S. national security interests; all of which color and shape the spectrum of study at the Naval Postgraduate School. NSA faculty and students engage in, contribute to, and gain from such disparate praxes as command, control, communications, and intelligence; information and data processing; military applications in space; and strategic deception and war gaming.

Stemming from these activities, and honed by rigorous exchanges with area specialists, foreign and domestic experts both civilian and military, pertinent politico-military research is underway in many fields: French security policies (Professor D. S. Yost); The U.S. and South Africa (Professor M. W. Clough); Soviet decisionmaking and strategic intervention in Middle America (Professor J. Valenta); Destabilizing effects of superpower anti-submarine warfare developments (Professor D. C. Daniel); Development of macroeconomic models of Caribbean economies (Professor R. Looney); Analysis of U.S. deception campaign during WW II (Professor K. Herbig); Development of methodology for testing airborne weapons and determination of damage to tanks (Professor R. H. S. Stolfi); Foreign investments in African development (Professor D. Winterford); Soviet confrontation with China--options for the USSR, the PRC, and the USA (Professor H. W. Jencks); Northeastern Asian security, and Japan-U.S. mutual defense (Professor E. A. Olsen); The Soviet

invasion of Afghanistan--impact on U.S. policies (Professor R. Magnus); and Southeast Asia and Australia/New Zealand--the forgotten lands (Professors C. Buss and S. Jurika); and development of a plan to establish a NSA laboratory for online search and storage of politico-military databases, with retrieval system, all so necessary for planners and decisionmakers (Professors E. Laurance and Lt Col R. Forney).

Several major NSA conferences were organized at NPS, among them an unusual convocation on Strategic Deception (Professor P. Parker); an arcane symposium on "Implications for East-West relations of recent developments in Angola, Ethiopia, Mozambique and Zaire" (Professor M. Clough); and a timely discussion on "Soviet-Cuban Strategy in the Third World after Grenada" (Professor J. Valenta). The conferences were productive, wide-ranging, and highlighted by published proceedings which were in demand by academic and politico-military organizations. Concomitantly, many NSA professors were making conference presentations at a host of symposia; exchanging briefs with CIA counterparts; participating as panelists, rapporteurs, and prolocuters in the US and abroad at international meetings. Many publications attested to the research endeavors of the NSA faculty. Six books, nearly a hundred articles in professional journals and major newspapers, and timely commentaries on controversial topics, appeared in print.

Recent requests for an index of NSA thesis titles, with abstracts, have been received from the CNO Executive Panel, the JCS, and Commanders-in-Chief of area commands. The scrupulous research by students and the close supervision of NSA faculty have produced timely and relevant theses of substantial merit in the politico-military and intelligence fields. The range of thesis titles reflects the breadth of student interests and rapidly changing international mileau.

120

Title: Soviet-American Conceptual Modeling

Investigator: Robert B. Bathurst, Adjunct Professor, National
                    Security Affairs

Sponsor: NPS Foundation Research Program

Objective: To develop and test a method for uncovering and
                    teaching differences in reasoning, value systems
                    and patterns of behavior between roughly socially
                    equivalent groups of Americans and Soviets.

Summary: The project was successful in perfecting and in
                    demonstrating a method for revealing and study-
                    ing unconscious cultural barriers to international
                    understanding. With the help of the research
                    funds, a major colloquim was held with participant
                    experts of international standing. Following,
                    with the aid of the grant, two workshop-laboratories
                    were held with internationally known ex-Soviet
                    experts participating. The result was the creation
                    of a format for seminars and laboratories to
                    educate Americans involved in diplomacy, education
                    or business in patterns of behavior which they can
                    expect from Soviet counterparts as well as in
                    patterns of behavior which they can expect among
                    their own colleagues. The method is now being
                    applied in Washington, D.C., where sessions are
                    being organized for training high-level government
                    officials. Plans are under way for further
                    demonstrations and sessions in New York and
                    Florida. The method appears adaptable for many
                    situations and groups.

Publications: "On Soviet Linguistics: Expropriating Utopia,"
                    an article directly related to the results of
                    this study is being published in a book entitled,
                    Soviet Deception, edited by Brian Dailey and
                    Patrick Parker, to be published in the fall of
                    this year. An article about the games appeared
                    in Community Spirit, October 1985, written by
                    Pamela Benda. Other materials and articles will
                    be forthcoming.

Title: An Automated Model for the Evaluation of Aggregated
                          Air Weapon System Combat Capabilities in the Middle
                          East

Investigator: C. L. Christon, LtCol, USAF, Instructor of National
                          Security Affairs

Sponsor: Director of Central Intelligence

Objective: In the short term to develop a methodology which
                          captures the key variables which dictate air weapon
                          system performance and translates them into homo-
                          geneously scaled measurements which can be further
                          aggregated into combat performance indices for Middle
                          Eastern countries. Initially looking at the evolution
                          of combat capabilities historically (1974 to 1984) the
                          model will be revised to permit look-ahead and
                          iterative analysis. The latter functions will be
                          incorporated in the micro-computer based version of
                          the mdoel.

Summary: This research project was funded by the DCI under the
                          Exceptional Intelligence Analyst Program to develop a
                          analytical tool to assist intelligence and security
                          planners in assessing the operational impact of on-
                          going or contemplated air weapons systems transfers to
                          the Third World. The Mideast region was selected as a
                          test-bed because of the high volume, volatility, and
                          differentiation of security assistance programs in the
                          area over the past decade. To date, the project has
                          identified and validated with the sponsor an approach
                          which essentially decomposes air weapon system per-
                          formance in four mission roles into 'bundles' of
                          measurable performance characteristics, reduces these
                          multivariate 'bundles' to a common measurement scale
                          using a factor analysis scoring process, and
                          recombines them using operationally weighted formulae
                          for each mission role. This process has been
                          completed and a data base finalized for 104 combat
                          aircraft and their variants. Initial aggregation
                          procedures using a four year air order of battle (AOB)
                          data base for 19 Mid-eastern countries generated the
                          desired product. However, the model needs to be
                          refined to permit inclusion of radar, gun, and missile
                          characteristics and to allow the effect of other
                          factors such as system reliability, maintainability,
                          and national support capacity to be demonstrated. As
                          a final step, the model needs to be transferred to a
                          micro-computer and given a format which permits
                          'user-friendly' manipulation and iterative analysis.

Title: Soviet Involvement in Caribbean

Investigators: R. Looney, Associate Professor of National Security
                     Affairs, and J. Valenta, Associate Professor of
                     National Security Affairs

Sponsor: Naval Postgraduate School Foundation

Objective: Determine to the extent possible, conditions
                     surrounding Soviet involvement in the Caribbean.

Summary: Found it was possible to profile the environment
                     surrounding Soviet involvement in the Caribbean.
                     Discriminant analysis profile of countries where the
                     Soviet Union was involved differed significantly from
                     those countries where Soviet involvement was not
                     present.

Title: French Security Policies

Investigator: D. S. Yost, Associate Professor of National Security
                    Affairs

Sponsors: Fritz Thyseen Foundation and International Institute
                    for Strategic Studies

Objective: To advance understanding of French policies in several
                    areas, including nuclear weapons programs,
                    interventionary forces, arms control, and European
                    security.

Summary: Research to date has focused on the French strategic
                    studies community, policy-making processes,
                    interventionary capabilities and contingencies in
                    Africa, nuclear weapons targeting, and policies
                    regarding European security. In each of these areas,
                    the existing literature in French and English has been
                    thoroughly reviewed, and numerous interviews with
                    French officials have supplemented and clarified
                    published sources.

Publications: D. S. Yost, France's Deterrent Posture and Security in
                    Europe, Part I: Capabilities and Doctrine, Adelphi
                    Paper No. 194, London: International Institute for
                    Strategic Studies, Winter 1984-1985.

                    D. S. Yost, France's Deterrent Posture and Security in
                    Europe, Part II: Strategic and Arms Control
                    Implications, Adelphi Paper No. 195, London:
                    International Institute for Strategic Studies, Winter
                    1984-1985.

                    D. S. Yost, France and Conventional Defense in Central
                    Europe, Boulder, Colorado: Westview Press, 1985.

                    D. S. Yost, La France et la securite europeenne,
                    Paris: Presses Universitaires de France, 1985.

                    D. S. Yost, "French Nuclear Targeting," in Strategic
                    Nuclear Targeting, ed. by D. Ball and J. Richelson,
                    Ithaca, New York: Cornell University Press,
                    forthcoming.

                    D. S. Yost, "Radical Change in French Defense Policy?
                    A Review Essay," Survival, 28 (January/February 1986).

DEPARTMENT

OF

PHYSICS

DEPARTMENT OF PHYSICS

The Physics Department has made a concerted effort to expand its research activities in acoustics, radiation damage and space physics. New faculty have been hired in all three fields: A. Atchley, S. Baker, S. Gnanalingam, and N. Glass. The recent acquisition of a pulsedelectronbeam machine will substantially increase our capabilities for both radiation damage and directed energy research. Dr. Nichols will continue for an additional year in the ONR Underwater Acoustics Chair to assist in expanding our ocean-acoustics research capabilities. Additional personnel to our research staff are: R. Mensh (electrooptic systems), J. Glendening (atmospheric modeling), and J. Lentz (optical propagation).

ACOUSTICS

Professors J. Sanders and A. Coppens are continuing their investigations of the propagation of acoustic waves in shallow water. Modeling of propagation from a fluid wedge into a fast bottom and within the water has been continued using the method of images. Propagation upslope, downslope, and crossslope in the wedge is being studied. A scale model experimental facility for investigation of propagation along regularly sloping bottoms has been constructed, and another facility more suitable for irregular profiled bottoms is being implemented.

Professor O. Wilson is engaged in a Navy sponsored book writing project. The book, "Introduction to the Theory and Design of Transducers for Underwater Sound", is to be published in the Fall of 1985. Professor Wilson has begun collaboration with Professor Garrett on developing techniques for hydrophone performance monitoring.

Professor Steven Garrett is engaged in several conventional underwater acoustical projects involving transducers: design and testing of fiber optic gradient hydrophones in collaboration with Dr. E. F. Carome; design of an automated sonar hydrophone testing facility to improve the shading of arrays; and, reciprocity calibration in unusual geometries. This latter project, using resonant calibrators in gases, was begun with LCDR C. Burmaster and is being continued in water using rigid and compliant slowwave resonators.

Additionally, Professor Garrett has moved into the space environment. Along with CDR Chuck Stehle and LT Scott Palmer, he has a "getaway special" project on the space shuttle to measure the vibroacoustic environment in the cargo bay. An acoustic refrigeration scheme for cooling spaceborne detectors is also under development.

Adjunct Professor Steven Baker has initiated a program in sediment acoustics. Projects slated for the coming year include the development of a new resonance method for determining the complex propagation constant of sound in a fluid saturated porous solid and the first direct measurements of the complex effective fluid mass density of an oscillating, nearly imcompressible fluid contained in a porous solid.

SURFACE PHYSICS

Professor Don Harrison uses computer simulations to study atom ejection effects produced by the ion bombardment of clean and chemically reacted metal surfaces. The results can be directly compared to data from Secondary Ion Mass Spectrometry (SIMS) and Fast Atom Bombardment (FAB) experiments. The project is supported by a special Opportunity Grant from the Office of Naval Research.

Recently published investigations studied the effect of electronic energy losses on atom ejection and nonlinear effects in collision cascades. Work in progress on low (less than 200 eV) energy ion bombardments anticipates the development of simulations of reactive ion etching.

CONDENSED MATTER

Professor N. Glass is engaged in theoretical research on surface excitations and their interaction with surface roughness, especially periodic roughness. Work is being carried out on resonant coupling of bulk light waves to surface polaritons on metal bigratings and on surface-polariton-enhanced Smith-Purcell radiation from an electron beam near a bigrating.

LASER AND PLASMA PHYSICS

Professor Fred Schwirzke is continuing his work on the investigation of the breakdown and unipolar arcing which occur when a laser beam interacts with a target surface. Unipolar arcing is an electrical plasmasurface interaction process which leads to crater formation, usually called laserpitting. At low irradiance, this is the only observable type of laser target interaction. With support from Naval Research Laboratory, measurements of laser induced unipolar arcing have been carried out on a variety of materials. Recently, an electron beam/flash x-ray machine has been acquired. Professor Schwirzke plans to use the facility for an experimental research program on pulsed power. The electron beam will be used to produce and sustain plasma and radiation conditions in argon which are appropriate for lasing in the XUV or soft x-ray spectral range. Pulse-power technology is becoming increasingly important in many energy and defense applications. MV voltage pulses can be induced when a conducting switch is rapidly opened in an inductive system. A microscopic model and scaling laws for a plasma opening switch have been proposed and will be tested on the new machine.

ENVIRONMENTAL PHYSICS

The Environmental Physics Group continues as a joint project of the Physics and Meteorology Departments, directed by Professors Kenneth Davidson, Gordon Schacher, and Will Shaw. Torben Mikkelsen from RISO National Laboratory, Denmark, and Jack Glendening from Washington State University have joined the group to work on its dispersion projects.

The group continues basic and applied research in atmospheric physics and meteorology, concentrating its efforts on modeling for overwater and coastal regions. Current major programs are properties of the marginal ice zone and diffusion in complex terrain. In both programs, the modeling work is supported be extensive field measurements. The following description concentrates on the diffusion work; descriptions of other work appear in the Meteorology Department report.

The data collection phase of the project to characterize Space Shuttle exhaust gas diffusion has been completed. A three laboratory joint effort, with NPS, RISO National Laboratory, and Iowa State University as participants, to model flow and diffusion at Vandenberg has begun. The program will continue for three years. The output of the program will be hand books of dispersion estimation procedures, hazard climatologies and a puff model which is parameterized for the Vandenberg complex terrain.

The characteristics of the turbulence structure on a steep hillside has been investigated with two arrays of three sensors. Work is underway to determine spatial and temporal coherence, the dependence of the turbulence intensity on local flow conditions, and the spectral distribution. The results will be compared to similar data from a flat terrain site.

The overwater diffusion work has culminated in the production of threat corridor displays that allow one to easily separate the effects of meander and relative diffusion.

LINEAR ELECTRON ACCELERATOR

At the LINAC, experimentation has continued on Cerenkov radiation, and new work on radiation effects has begun. The Cerenkov radiation produced by the LINAC electron beam traveling in air gives information on the spatial structure of the elctron beam. In principle, microwave observations give information about the gross structure of the beam while higher frequency measurements will give information about a single charge bunch. A paper suggesting Cerenkov radiation as an electron beam diagnostic has been published. Experiments and calculations of microwave Cerenkov radiation are continuing under the sponsorship of NAVSEA and DARPA. Calculations of the time development of Cerenkov radiation are underway.

Dr. Maruyama has returned to his permanent duty station at NBS and Professor Buskirk has returned from Los Alamos where he worked with high current electron beams.

Professor Dimiduk has began studies of the behavior of the semiconductor materials CdTe and HgCdTe electron irradiation. The degradation of various composition of GaAs1xPx LEDs under electron irradiation has been measured. Damage studies are continuing with IrGaAsP LEDs and IrGaAs detectors for 1.3 micron fiberoptic communications. Work has started on irradiating SOI transistors.

This work will continue, with the aid of Prof. A. Fuhs, Department of Aeronautics, Prof. S. Michael Department of Computer and Electrical Engineering, Prof. F. R. Buskirk and Prof. J. R. Nieghbours, Department of Physics.

ATOMIC PHYSICS

Professor Raymond Kelly has continued to operate the Spectroscopic Data Center with support from NASA and NBS. His compilation of spectroscopic data has continued to be an important source of data for researchers everywhere and is constantly used in the areas of high-temperature plasmas and solar physics.

A compilation of vacuum ultraviolet (VUV) spectral lines below 2000A for all element between hydrogen and argon was published in 1982. A new work covering the elements from potassium to krypton is to be published in 1986.

Current plans are to extend the VUV spectral line compilation to elements beyond Krypton.

EXPLOSIVE CHEMISTRY

Professors Richard Reinhardt and Gilbert Kinney have continued their work, sponsored by the Naval Weapons Center and the Naval Surface Weapons Center, on the subject of chemical equilibria and overpressures resulting from the internal explosions of conventional and explosive fuels in the presence of reactive metals.

Calculations were performed for the temperature, pressure, and product yield expected for the adiabatic internal explosion of aluminum loaded PBX material in air. Calculations were begun for the related problems for magnesium plus aluminum. This is a long-term project which is expected to continue.

ELECTRO-OPTICS

Professor A. W. Cooper and E. A. Milne and students are engaged in computer modelling of performance of infrared systems in the marine atmospheric environment. The major thrust of the program is the evaluation of effectiveness of offboard countermeasure devices and tactics by computer simulation of encounters between incoming missiles and a ship protected by such devices. The Stochastic Infrared Engagement Model (SIREM) simulation code developed at Naval Research Laboratory has been modified and installed in the Wargame Laboratory at NPS. Provision has been made for the inclusion of results of LOWTRAN6 propagation code already installed in interactive form on the IBM 3033. Further improvement in the code and evaluation of system designs and tactics in a variety of appropriate scenarios are in progress.

In conjunction with this program, Professors A. Cooper, E. Crittenden, and G. Rodeback are engaged in development of a light, low-cost, expendable laser altimeter for possible incorporation in developmental offboard countermeasure devices for shipboard use. This involves design and prototype construction and testing. Three thesis students are currently engaged in this program.

Professors A. Cooper, E. Crittenden, and Mr. W. Lentz have been progressing in the establishment of an Infrared Surveillance and Target Designation study facility, based on the Advanced Development Model of the AN/SAR-8 IRSTD. This system is currently undergoing refurbishment and modification, and the data acquisition and recording system being assembled. The scanner will be mounted in a rooftop location with access to shoreline, sea horizon, and airport runway views. This system is then to be applied to the development of a statistical data base of background and target scenes under instrumented conditions, and will be used as a test bed for technology evaluation and the development and testing of algorithms for data processing, clutter rejection and range estimation.

A computer program has been written by Prof. Milne for the IBM-PC that can be used to calculate the reflection coefficients for reflection from multilayered coatings on a dielectric or conducting substrated. This program is being adapted to layers of non-isotropic and non-homogeneous media. Another computer program under development is for the calculation of spot size due to atmospheric turbulence, spherical aberration, and diffraction.

131

TITLE: Microwave Cerenkov Radiation

INVESTIGATORS: F. R. Buskirk, Professor of Physics and
J. N. Neighbours, Professor of Physics

SPONSOR: Naval Sea Systems Command

OBJECTIVE: To develop quantitative understanding of the
microwave radiation from a periodic charged
particle beam.

SUMMARY: Microwave radiation in both x and k band have been
detected when the NPS linac beam is allowed to
propagate in air. This radiation has been
identified as resulting from coherent Cerenkov
radiation occuring as a result of collective
radiation by each of the electron bunches in the
linac beam. A theory of the effect has been
developed for the radiated power and current
research efforts are directed towards testing its
range of validity in the far field. The efforts
of charge bunch structure are also under
investigation.

PUBLICATIONS: J. R. Neighbours, F. R. Buskirk, and A. Saglam,
"Cerenkov Radiation from a Finite Gas Cell,"
Physical Review A. 29 3246-3252 (June 1984)

F. R. Buskirk and J. R. Neighbours, "Time
Development of Cerenkov Radiation," Physical
Review A31 (1985) p. 3750-3755

F. R. Buskirk, J. R. Neighbours, "Relation between
Cerenkov Radiation and EMP," submitted to Physics
Review.

THESES DIRECTED: M. Vujaklija, "Cerenkov Radiation from Periodic
Electron Bunches for Finite Emission Length in
Air," Master's Thesis, December 1984.

E. R. Turner,"Form Factor Effects on Microwave
Cerenkov Radiation", Master's Thesis, Dec 1984

R. G. Bruce, "Cerenkov Radiation From Periodic
Bunches For a Finite Path in Air," Master's
Thesis, 1985

TITLE:	Establishment of Infrared Search and Target Designation Research Facility
INVESTIGATORS:	A. W. Cooper, Professor of Physics, Principal Investigator, E. C. Crittenden, Jr., Distinguished Professor of Physics Emeritus, and W. J. Lentz, Research Associate
SPONSOR:	SPAWARSYSCOM, PDW107-3
OBJECTIVE:	To establish at Monterey as part of the activities of the Naval Academic Center for Infrared Technology (IRSTD), a research and measurement facility and documentation center relating to ISRT and other IR systems; in support of this to receive, refurbish, modify and mount for operation the Advanced Development Model of the AN/SAR-8 Infrared Search and Target Designation system; to develop a data recording system; and to initiate a program of research relating to sea, land and air background measurement, target signatures, cloud radiance, and evaluation of processing algorithms.
SUMMARY:	The IRSTD ADM has been received and evaluated, and many needed repairs carried out. Plans have been prepared for a mounting location on the penthouse roof area of Spanagal Hall. The cryogenic cooling unit and the Dewar insulating unit have been found to be defective and are being replaced with locally designed and fabricated systems. A data processing system based on a Masscomp minicomputer, and Ampex 6-Megabyte optical disc permanent memory and a fiber-optic data cable, has been designed and the equipment purchased for recording raw video data. A 400 Hz motor generator set has been acquired and modified. Initial consideration has been given to range estimation algorithms, and the stability of the mounting site has been evaluated.
	Quarterly on-site progress reviews have been held.
PUBLICATIONS:	Quarterly progess reports have been provided to the sponsor.
PRESENTATION:	A summary discussion of the project and the NACIT operation was presented to the Golden Gate Chapter, Association of Old Crows, meeting at Monterey, 23 August 1985.

THESES DIRECTED: D. A. Gannon, "The Feasibility of Range Estimation with Passive Infrared Sensors", <u>Master's Thesis</u>, September 1985.

A. Manalopoulos, "Infrared Background and Target Measurement", <u>Master's Thesis</u>, December 1985

C. E. Lewis, "The Infrared Search and Target Designation System AN/SAR-8 ADM at the Naval Postgraduate School", <u>Master's Thesis</u>, December 1985.

H. Mor, "Vibration Analysis of Mounting Location for the AN/SAR-8 ADM", <u>Master's Thesis</u>, March 1986

TITLE: Technical Support to Off-Board Countermeasure
                          Programs

                          This project comprises the work performed under
                          the three proposals;
                          a)   Infrared Countermeasures Technical Development
                          b)   Counter ARM Decoy Development Program Support
                          c)   Ship Launched Decoy Development Program Support

INVESTIGATORS: A. W. Cooper, Professor of Physics, Principal
                          Investigator, E. C. Crittenden, Jr., Distinguished
                          Professor of Physics Emeritus, G. W. Rodeback,
                          Associate Professor of Physics Emeritus, E. A.
                          Milne, Associate Professor of Physics

SPONSOR: SPAWARSYSCOM, PDW107-5

OBJECTIVE: To provide for engineering and technical support
                          to the NATO SEA SNAT program, the Counter ARM
                          Decoy Program, and the Ship Launched Electronic
                          Decoy Program by continuing development of a low
                          cost laser altimeter, by evaluating and improving
                          interactive scenario models and by conducting IR
                          decoy effectiveness studies.

SUMMARY: Work has proceeded on the design of a working
                          model of a small, light, low cost optical (i.e.
                          laser) radar head for possible use for the
                          deployment of disposable off-board decoy devices.
                          Theoretical analysis and parallel experimentation
                          have led to construction and testing of four
                          "prototype" models, of which the last three have
                          been tested in the field, using a high bridge over
                          a reservoir to simulate ranging on the ocean
                          surface. A system trade-off equation has been
                          developed and validated against laboratory and
                          field measurements to enable confident
                          extrapolation to performance under "at sea"
                          conditions. Results to date show usable signals
                          at 150 meter range under medium-high sea
                          conditions. Extrapolation indicates a successful
                          design to be feasible within the severe size and
                          cost constraints. A fifth model is under
                          construction to optimize the parameters to achieve
                          design goals. This model should then be tested at
                          sea probably from a helicopter. The DMAD infrared
                          decoy engagement modelling computer program
                          developed at Naval Research Laboratory by

Calomiris and others was installed on the VAX-780 in the War Gaming Laboratory at NPS, during the first quarter of FY85. Before production runs could be achieved, solution had to be found to the absence of the PLOT-10 routine and hard copy capability in the WARLAB, and the incompatibility of the program's data input technique with the VAX operating system. An interim solution was found by programming the output to a Tektronix plotter unit using the DI3000 plot routine, which gave a less than ideal solution. The DISSPLA package has since been obtained under this contract. Input schemes have been evolved around the changing operating system of the VAX; the NAMELIST input has been reinstated and progress is being made toward batch processing. The source code has been restructured for ease of modification, and a technique of incorporating LOWTRAN propagation information has been adopted. Progress is being made toward implementation of the DMAD program in a bench-top environment. A TEMPEST certified microcomputer has been ordered.

Baseline results for decoy effectiveness against standard threat missiles on an expected flight path have been obtained as a function of launch angle, deployment range and burn time of decoy, using a known decoy parameters. These results have been compared with published results of a previous study. Altitude has been included as a deployment parameter. These results are being analysed, and a report is in preparation.

THESES DIRECTED: J. W. Wilson, "Computer Modelling of IR Encounters and Countermeasures Effectiveness", Master's Thesis, December 1985.

J. P. Gilio, "Initial Development of a Laser Altimeter", Master's Thesis, September 1985.

V. D. Reed, "Development in Modelling the Use of Infrared Off-Board Countermeasures in an Infrared Anti-Ship Missile Scenario", Master's Thesis, September 1985

M. A. Kuharik, "Ship Launched Infrared Countermeasures Modelling", Master's Thesis, December 1985.

137

Title:	Radiation Effects on Infrared Materials and Devices
Investigator:	K.C. Dimiduk, Assistant Professor of Physics
Sponsor:	NPS Foundation Research Program
Objective:	To study the effects of electron irradiation on infrared semiconductor materials and devices.

Summary:

The effect of radiation damage due to 30 MeV electrons on bulk semiconductors and certain devices was studied. The bulk material experiments were conducted on mercury cadmium telluride, used to make infrared detectors, and the related substrate material cadmium telluride. Wafers were cooled to approximately 100K and irradiated to fluences of 10^{13} e/cm^2 to 6×10^{15} e/cm^2. Measurements of conductivity or resistivity, mobility and carrier concentration at various temperatures were used to assess the effect of the irradiations.

The devices chosen for study were emitters and detectors used for fiber optic systems. Preliminary measurements were made on long wavelength (1.3 micron) InGaAsP LEDs and InGaAs photodiodes. From this it was determined that additional work was needed to establish a measurement technique. That was done using shorter wavelength GaAsP LEDs since they were considerably cheaper. These LEDs turned out to be significantly softer than earlier LEDs reported in the literature, indicating that the GaAsP work was important to pursue. Currently, additional 1.3 micron devices of the original composition are being studied using the techniques developed on this project under an outside supported follow-on project.

Publications:	K.C. Dimiduk, C.Q. Ness and J.K. Foley, "Electron Irradiation of GaAsP LEDs," <u>Transactions on Nuclear Science</u>, Volume NS-32, Number 6, pp. 4010-4015, December 1985.
Conference Presentations:	K.C. Dimiduk, C.Q. Ness, and J.K. Foley, "Electron Irradiation of GaAsP LEDs," 1985 Annual Conference on Nuclear and Space Radiation Effects, Monterey, CA, July 1985.
Theses Directed:	C.Q. Ness, "Electron Irradiation of Light Emitting Diodes," <u>Master's Thesis</u>, December 1984.
	C.P. Bauer, "Electron Irradiation of n-Type Cadmium Telluride," <u>Master's Thesis</u>, March 1985.
	D.G. Morral, "Electron Irradiation of p-Type Mercury Cadmium Telluride," <u>Master's Thesis</u>, June 1985.

Thesis Directed (cont.):   J.K. Foley, "30MeV Electron Beam Irradiation Effects on GaAsP LEDs, " Master's Thesis, June 1985.

Title:	Radiation Effects on Silicon on Insulator Transistors
Investigator:	K.C. Dimiduk, Assistant Professor of Physics
Sponsor:	Naval Oceans Systems Center
Objective:	To study the effects of electron irradiation on silicon on insulator transistors.
Summary:	The effect of radiation damage due to 30 MeV electrons on silicon on sapphire, n-channel, insulated gate field effect transistors was studied. Irradiations were done at room temperature for doses of 10^4 to 10^6 Rads (Si). Measurements of threshold voltage, saturation transconductance and leakage current were used to assess the effect of the irradiations. Room temperature annealling was also considered.
Theses Directed:	R.A. Pornaras, "Electron Irradiation of N Channel Silicon on Sapphire Insulated Gate Field Effect Transistors (IGFET), Masters Thesis, December 1985.

TITLES:	Evaluation of SONAR Hydrophones by Automated Electrical Impedance Measurement
	Hydrophone Array Modeling and Performance Prediction
	On-site Immittance Measurement of the AN/BQR-7 Hydrophone Stave and Preamplifier
	On-board Tests of DT-276 Hydrophones Using Automated Vector Impedance Equipment
	Vibrational Model Analysis of the DT-276 Hydrophone
INVESTIGATORS:	S. L. Garrett, Associate Professor of Physics, and O. B. Wilson, Professor of Physics
SPONSORS:	Naval Underwater Systems Center Naval Sea Systems Command
OBJECTIVES:	To develop more operationally relevant performance criteria for the DT-276 hydrophone and to adapt new digital technology to the monitoring of transducer performance.
SUMMARY:	Computer software has been developed which permits Naval personnel in the field to use a micro-computer and associated equipment to make complex immitance measurements on the DT-276 hydrophone and determine critical transducer parameters. The first stage of development of a program which should enable a sonar technician to determine changes in sonar beam patterns due to degradation was made. A model analysis of the DT-276 hydrophone was made using Finite-element models that include piezoelectric effects which has provided understanding of the measured electrical resonances.
THESES DIRECTED:	J. D. Johnson, Complex Immittance Measurement System for Shipboard Measurement and Evaluation of Hydrophones, M.S. Thesis, December, 1984.

TITLE:	Fiber Optic Gradient Hydrophone
INVESTIGATOR:	Steven L. Garrett, Associate Professor of Physics
SPONSOR:	Naval Electronics Systems Command (ELEX 190) and Space and Naval Warfare Systems Command (Naval Research Laboratory (Code 1332)
OBJECTIVE:	To design, fabricate, and test an interferrometric fiber optic acoustic sensor system which is directional and compact as part of a continuing research program in fiber optic sensor systems.
SUMMARY:	During this period progress was made on several of the interrelated tasks in the design, fabrication and test areas. Several all-fiber dipole sensors were constructed using both Mach-Zehnder and Michelson interferometers with 2x2 and 3x3 couplers, and three different diode lasers types. Sensitivity measurements in our laboratory corroborated basic sensitivity calculations based on known and measured material properties of the fiber mandrels. A sea trial apparatus with directional sensitivity measurement capability was constructed and sucessfully tested aboard the R. V. Acañia and construction was begun on the fiber optically read magnetic compass. Problems involving the demodulation of the interferometer output without the use of a piezoelectric phase shifter were addressed by the design of a new sensor with acoustically induced phase shifts which were significantly greater than all previously known sensors of this type.
THESIS DIRECTED:	G. E. MacDonald, Fiber Optic Gradient Hydrophone Construction and Calibration for Sea Trial, Master's Thesis, March 1985.
PATENT APPLICATION:	A. Migliori, G. W. Swift, and S. L. Garrett, Remotely readable fiber optic compass, applied March 21, 1985, Los Alamos Case Number S-62, 240.

TITLE: Measurement of Acoustic Ambient Noise in the
Cargo Bay of the Space Shuttle During Launch

INVESTIGATORS: S. L. Garrett, Associate Professor of Physics, and
O. B. Wilson, Professor of Physics

SPONSOR: U. S. Air Force - Space Division

OBJECTIVE: To perform and to interpret measurements of the
environmental acoustic noise in the audible
frequency range at one location in the cargo bay
of the space shuttle during launch using the
facilities available in the "Get Away Special"
(GAS) program. This work is part of a larger
continuing program (R. Panholtzer, Principal
Investigator) of GAS experiments conducted as part
of the NPS Space curriculum.

SUMMARY: During this period the design and fabrication of
space qualified prototype hardware, and test of
that hardware which generate and detect the
acoustic signals was completed. A "base reflex"
type loudspeaker enclosure was constructed and
optimized along with the oscillator and amplifier
necessary to generate sufficient sound levels
in the cargo bay for pre-launch determination of
the cargo bay acoustic normal modes. A microphone
vibration isolator with a natural frequency below
15 Hz was constructed. This isolator represented
a significant improvement over the 115 Hz system
which had been in use up to this time. A computer
controlled shaker table system of our own design
was programmed to simulate the shuttle's
vibrational spectrum in twenty-one, one-third
octave frequency bands between 20 Hz and 2 kHz for
automated transmissibility measurements. Static
deflection and transient response measurements
verified the axial and radial transmissibility
measurements. Other components in the GAS system
such as the solid state data recorder, matched
filter, controller, and power supply are described
by other investigators.

CONFERENCE
PRESENTATION: S. E. Palmer, S. L. Garrett, O. B. Wilson, and
S. W. Yoon, Autonomous Measurement of Normal
Acoustic Modes in STS Cargo Bay, AIAA Fall
Meeting, Houston, TX.

THESIS DIRECTED: C. D. Stehle, Vibration Isolation of a Microphone,
Master's Thesis, September 1985.

TITLE: Reciprocity Calibration in Unconventional
                          Geometries (Phase IV)

INVESTIGATOR: Steven L. Garrett, Associate Professor of Physics

SPONSOR: Office of Naval Research (Physics Division)

OBJECTIVE: To test extensions of the reciprocity method for
                          absolute calibration of electroacoustic
                          transducers beyond the traditional geometries.
                          This is Phase IV of a continuing program in
                          physical acoustics research.

SUMMARY: During this period we completed the experimental
                          phase of the high precision reciprocity
                          calibrations in an air filled planewave resonator
                          and have received the results of the Bureau of
                          Standards calibration of our WE 640AA standard
                          microphone. Our results agreed with the NBS to
                          within 0.03 dB below 1500 Hz. The discrepancy
                          above that frequency is currently being tested by
                          the Canadian National Research Council. We also
                          completed the initial phase of our experiments
                          which extend this technique to a water filled
                          compliant tube which permits low frequency
                          calibrations to be performed in a test apparatus
                          of compact dimensions. This method takes
                          advantage of the reduced wave speed in a
                          cylindrical water column bounded by a compliant
                          material to reduce the length of a standing wave
                          to dimensions that can be easily handled in the
                          laboratory. The results of the first series of
                          experiments show a mean reproducibility/self-
                          consistancy of 0.8 dB with a sound speed of 350
                          meters/sec.

CONFERENCE   M. B. Johnson and S. L. Garrett, Reciprocity
PRESENTATION: calibration in a compliant cylindrical tube, J.
                          Acous. Soc. Am. 78, S54 (1985)

THESES DIRECTED: M. B. Johnson, Reciprocity calibration in a
                          compliant cylindrical tube, Master's Thesis, June
                          1985

                          C. L. Burmaster, Reciprocity calibration in a
                          plane wave resonator, PhD Thesis, December 1985

TITLE:	The Interaction of Electromagnetic Waves with Periodically Rough Surfaces on Conductors
INVESTIGATOR:	N. E. Glass, Adjunct Teaching Professor
SPONSOR:	NPS Foundation Research Program
OBJECTIVE:	To develop mathematical tools to analyze the interaction of electromagnetic waves with rough conducting surfaces, for the purpose of studying resonant absorption and field enhancement at such surfaces. To study, theoretically, Smith-Purcell radiation from electron beams above grating surfaces, for the purpose of generating soft x-rays.

SUMMARY:	An exact theory of the scattering of electromagnetic waves, with resonant excitation of surface-polaritons, from conducting bigrating surfaces was numerically fit to the results of recent experiments, and was then compared to the predictions of a standard perturbation theory. Many of the discrepancies between the experiment and perturbation theory were narrowed or eliminated by the exact theory. The perturbation theory's degree of error in predicting the surface profile was determined. A new perturbation theory was derived analytically, which permits the calculation of the scattering intensity, through a 4x4 matrix equation, at points corresponding to 2-polariton excitations (around mini-gaps in the surface-polariton dispersion relation). An exact expression for the intensity of Smith-Purcell radiation from electrons travelling above a bigrating surface, of finite conductivity, was also developed. This is the first such calculation which permits the electron beam to have an arbitrary orientation parallel to the surface and the first to consider a doubly periodically corrugated surface. The result is a set of interference terms not seen in the case of a classical grating. This work will allow one to determine the extra enhancement in the radiated intensity due to the simultaneous resonant excitation of two surface-polaritons.

PUBLICATION:	N. E. Glass and A. A. Maradudin, "Polariton Resonant Absorption in a Bigrating" Exact Theory Compared to Recent Experiments and to Perturbation Theory," Optics Communications, accepted for publication.

CONFERENCE
PRESENTATION: The results of this research will be given in an
                 invited-review-paper, to be presented by A. A.
                 Maradudin, at the forthcoming International Laser
                 Science Conference in Dallas, TX   18-22 Nov 1985.

146

TITLE:	Classical Trajectory Simulation Studies of High and Low Energy Particle-Beam Interactions
INVESTIGATORS:	D. E. Harrison, Jr., Professor of Physics with Dr. Mario M. Jakas, Post-Doctoral Research Associate (visiting scientist from Centro Atomico Bariloche, Argentina).
SPONSOR:	Office of Naval Research (Special Research Opportunity Grant: High and Low Energy Particle-Beam Interactions with Solids).
OBJECTIVE:	Continue study of the effects produced when ions bombard clean and chemically reacted single crystal metal surfaces, to understand mechanisms and to coordinate with experimental investigations. Study damage produced in target surface by bombarding ions. Study fundamental properties of ion bombardment induced cascades in solids.
SUMMARY:	Classical trajectory simulations are used to study the cascade of atoms produced when an ion strikes a target surface. Calculations have been done for combinations of systems using Ar^+, O^+, O_2^+ and various metal ions in combination with Cu, Ni, W, Mo, Ti, V, and Nb targets. Effort this year has been concentrated on fundamental problems and computer program improvement. The program can now be used to study atom ejection by low energy (<100 eV) ions.
	The importance of energy losses by heavy ions to electronic processes has been investigated in detail, papers published, and prepared for publication.
	Non-linear collision effects in cascades are being investigated, and two papers prepared for publication.
PUBLICATIONS:	R. P. Webb and D. E. Harrison, Jr., "A Molecular Dynamics Simulation of the Time Dependence of Surface Damage Production in Ion Irradiated Metal Targets," Vacuum 34 (10/11), 847 (1984).
	R. P. Webb, D. E. Harrison, Jr., and K. M. Barfoot, "Microscopic Phase Transitions in Molecular Dynamics Simulations of Low Energy Ion Irradiation of Metals," Nucl. Instrum. Method. B 7/8, 143 (1985).

M. M. Jakas and D. E. Harrison, Jr., "Influence of Electronic Energy Losses on Atom Ejection Processes," Phys. Rev. B15, $\underline{30}$(6), 3573 (1985) (rapid communication).

M. M. Jakas and D. E. Harrison, Jr., "Computer Studies of the Reflection of 30 KeV N_2' Ions from a (010) Cu Surface," Surface Science $\underline{149}$, 500 (1985).

R. Kelly and D. E. Harrison, Jr., "A Summary of the Theory of Preferential Sputtering of Alloys," Material Science and Engineering $\underline{69}$, 449 (1985).

CONFERENCE
PRESENTATIONS: D. E. Harrison, Jr., and M. M. Jakas, "Inelastic Energy Losses in Cascade and Atom Ejection," IBA 7 '85, Berlin, FDR.

D. E. Harrison, Jr., and M. M. Jakas, "Simulation of the Atomic Collision Cascade," REI 3 '85, Guilford, UK, invited paper.

Invited Speaker (to show movie): Vth. International Workshop on Inelastic Ion-Surface Collisions, Phoenix AZ, January 1985.

Invited Speaker: Local Area Seminar on Computer Simulation, Xerox PARC, June 1985.

THESES DIRECTED: None.
Two M.S. level students, LT Steven M. Webb and LT Mark R. Polnaszek, have started their theses for June 1986.

TITLE:	Effects of Turbulence on Airborne Optical Projectors
INVESTIGATORS:	Edmund A. Milne, Associate Professor of Physics and G. Wayne Rodeback, Associate Professor of Physics
SPONSOR:	Pacific Missile Test Center
OBJECTIVES:	To measure the atmospheric turbulence on a path between an airplane and the ground, and to measure the weighting function for scintillation due to turbulence ona folded optical path.
SUMMARY:	Measurements were made of the weighting function for scintillation due to turbulence on a folded optical path in an optical tunnel. Turbulence was introduced by a turbulence chamber that could be inserted into various positons in the tunnel and the scintillation for a one way path and a folded were measured. No measurements were made of the scintillation on an optical path from an airplane to ground since PMTC did not have any operations for us to support. The project has since been cancelled.
THESES DIRECTED:	Jong Hwan Kim, "Measurements of Folded Path Optical Scintillation Using a forner Cube, a Cat's Eye and a Flat Mirror Reflector," Master Thesis, December 1984.
	Byung G. An, "The Weighting Function for Scintillation on a Folded Path," Master's Thesis, December 1984.
	Jungbok Lee, "Characterization of the Turbulence in a Turbulent Source Chamber," Master's Thesis (not completed).

TITLE: Spot Size for Optical Systems with Various
                    Aberations

INVESTIGATORS: Edmund A. Milne, Associate Professor of Physics

SPONSOR: Pacific Missile Test Center

OBJECTIVE: To write one or more computer programs to
                    determine the spot size due to aberations,
                    diffraction and atmospheric turbulence on the
                    image of a point source.

SUMMARY: A program to calculate the spot size due to
                    spherical aberation was written. This was used
                    along with the program "Predict" written earlier
                    to determine the spot size for various lenses
                    under various conditions requested by the sponsor.

TITLE: Synthesis of Minimal Scattering Profiles in
                        Inhomogeneous Anisotropic Material

INVESTIGATORS: Michael A. Morgan, Associate Professor of
                        Electrical and Computer Engineering and Edmund A.
                        Milne, Associate Professor of Physics

SPONSOR: Office of Naval Research

OBJECTIVE: To develop computer programs that can be used to
                        synthesize material profiles for and which
                        yield "minimal" scattering from the inhomogeneous
                        slab.

SUMMARY: Computer programs have been written for isotropic
                        homogeneous layers on an infinite isotropic
                        substrate material and for anisotropic layers
                        on an infinite anisotropic substrate. The two
                        programs have been verified using data for known
                        situations and comparison of results.

THESIS DIRECTED: Dean L. Fisher, "Investigation of Scattering From
                        Anisotropic Material," Master's Thesis, Sept. 1985

TITLE:	The Pumping of Photochemical Species in the Middle Atmosphere by Acoustic-Gravity Waves
INVESTIGATORS:	Steven F. Nerney, Associate Professor of Physics and G. W. Adams, Senior Research Professor of Physics at Utah State University.
SPONSOR:	NPS Foundation Research Program
OBJECTIVE:	To purchase an office-based computer system compatible with those used at USU in conjunction with the HF radar program as well as the photochemical modelling program at USU.
SUMMARY:	The AT&T PC 6300, Bernoulli Box, Micom Modem and Epson printer are all installed in my office. Preliminary work has been done on photochemical pumping of minor species by passing gravity waves. The concentrations of minor species have been plotted as a function of time based on a simple computational scheme which solves the differential equations for those concentrations. We are just beginning this study.
CONFERENCE PRESENTATIONS:	"Modelling Mesospheric Chemical Pumping Due to Temperature Variations," R. A. Armstrong, S. F. Nerney, and G. W. Adams was presented by Dr. Armstrong at the spring meeting of the American Geophysical Union.

TITLE: Air Motion at the Space Shuttle Hydrogen Flare Stacks

INVESTIGATORS: G. E. Schacher, K. L. Davidson, and S. Larsen

SPONSOR: Air Force Space Division

OBJECTIVE: Determine the possible hazards caused by transport of the hydrogen flare in the ambient wind field at Vandenberg Air Force Base

SUMMARY: Hydrogen gas is burned off during the near-launch phase of the Space Shuttle from flare stacks that are in the immediate launch site vicinity. When there is a moderate wind, the behavior of the flare plumes can be controlled by momentum transfer and the plumes remain imbedded in the ambient flow for long distances. This could produce a hazard to nearby structures and presonnel. The purpose of this study was to determine if the air motion could transport the plume in such a way as to do damage. Local flow and turbulence have been analyzed to determine plume location and the statistics of plume motion. Methodologies for heat deposition calculations have been developed.

PUBLICATIONS: G. E. Schacher, C. E. Skupniewicz, and T. Mikkelsen, "Turbulence Structure on a Steep Hillside, Application to Transport of a Hot Plume," Proceedings of the 7th Symposium on Turbulence and Diffusion

G. E. Schacher and C. E. Skupniewicz, "Air Parcel Motion at the Vandenberg Hydrogen Flare Stacks," NPS-61-86-005

TITLE:	Parameterization of Overwater Diffusion
INVESTIGATORS:	G. E. Schacher and K. L. Davidson
SPONSOR:	Naval Surface Weapons Center
OBJECTIVE:	Determine the correct parameterization for overwater diffusion to be used in Naval chemical warfare threat assessment models.
SUMMARY:	The environmental physics group has a large quantity of horizontal wind variability data that was obtained overwater. Wind variability drives diffusion and parameterization of these data can lead to correct parameterization of plume properties. Surface layer parameters: wind vector, stability, friction velocity and boundary layer parameters: inversion height and convective mixing velocity were investigated. It was found that only the surface layer parameters are useful. Apparently the wind variability is not convectively driven due to the small overwater air-surface temperature difference.
PUBLICATIONS:	One report and one open literature publication are in preparation.

TITLE: Parameterization of Overwater Plume Meander

INVESTIGATOR: G. E. Schacher

SPONSOR: Naval Environmental Prediction Research Facility

OBJECTIVE: To seperate the meander and relative diffusion in
                    overwater plume characteristics and modify the
                    Navy overwater diffusion model to correctly treat
                    meander.

SUMMARY: Relative diffusion (spreading) about a plume
                    centerline and meander of the centerline are
                    controlled by different scales of turbulence.
                    When dealing with either short time averages or
                    burst releases of material, it is necessary to
                    separate the two effects. Overwater plume data
                    collected by NPS have been analyzed and the short
                    and long term effects separated, yielding the
                    needed model parameters. A new overwater dif-
                    fusion model and display have been developed. The
                    display uses a Gaussian formulation for relative
                    diffusion and a probability envelope to locate and
                    indicate possible movement of the centerline due
                    to meander.

PUBLICATIONS: C. E. Skupniewicz and G. E. Schacher, "Dispersion
                    Parameterization for Overwater Plumes," Accepted
                    Atmospheric Environment

                    C. E. Skupniewicz and G. E. Schacher, "Assessment
                    of the Performance of an In-Field Gaussian Plume/
                    Puff Model for Overwater Use, NEPRF CR-85-01

TITLE:	Space Shuttle Exhaust Acid Deposition Hazard
INVESTIGATOR:	G. E. Schacher, K. L. Davidson, S. Larsen, and E. C. Takle
SPONSOR:	U. S. Air Force Space Division
OBJECTIVE:	Develop a handbook of diffusion scenarios and scenario climatologies for the Space Shuttle Exhaust hazard

SUMMARY: The Space Shuttle booster engines exhaust a large quantity of hydrochloric acid, which can be a hazard to personnel and structures. Damage to structures can occur due to near field rain-out while personnel can be affected in the near field and at long distances by gaseous and aerosol components in the exhaust cloud. The transport and diffusion of a large cloud in terrain as complex as at Vandenberg AFB is little understood. There is little hope, at this time, to be able to develop a fundamental 3-D model for Vandenberg. Rather than attempt that approach, the purpose of this work is to develop a transport and diffusion handbook based on screening calculations, a 3-D flow model, a puff dispersion model, and detailed climatologies for specific hazard scenarios. A parallel effort to investigate the basic physical processes that control diffusion, using a 2-D finite element model, is also underway. This is a three year project that involves three laboratories: NPS, Iowa State University, and Riso National Laboratory, Denmark.

PUBLICATIONS: G. E. Schacher, M .J. Buell, C. E. Skupniewicz, S. Larsen, and E. S. Takle, "Characterizing Turbulence for Complex-Terrain Diffusion Modeling," Proceedings of the 7th Symposium on Turbulence and Diffusion.

M. J. Buell, "Mean Flow and Turbulence in Complex Terrain," NPS Thesis, March 1985

TITLE: Vertical Winds in Complex Terrain

INVESTIGATORS: G. E. Schacher and K. L. Davidson

SPONSOR: Air Force Space Division

OBJECTIVE: To develop a data base of mean vertical wind and
                    turbulence for diffusion modeling for Vandenberg
                    AFB.

SUMMARY: NPS has gathered one full year of data at
                    Vandenberg AFB from existing towers and sensors.
                    This data base contains only the horizontal
                    component of the wind. Bivane anemometers were
                    installed on the existing towers to obtain
                    vertical wind data and data was obtained for a six
                    month period. A complete data base is now in
                    existence for site specific flow and diffusion
                    modeling for Vandenberg.

TITLE: Isoplanatic Angle System Development and
Measurement Program

INVESTIGATOR: D. L. Walters, Associate Professor of Physics

SPONSOR: Rome Air Development Center (DARPA)

OBJECTIVE: To develop optical instrumentation to measure the
atmospheric isoplanatic angle.

SUMMARY: The atmospheric isoplantic angle is a critical
parameter for ground based laser systems. It is
related to the amount of atmospheric turbulence
encountered along an optical path. The Strategic
Defense Initiative program includes a ground based
option. Knowledge of the atmospheric isoplanatic
angle is necessary to estimate the performance of
potential SDIO systems. Stellar radiation that
propagates through the atmosphere encounters phase
and intensity variations that are proportional to
the amount of atmospheric turbulence along the
path. By carefully apodizing a telescope
aperture, the normalized variance of the stellar
intensity fluctuations provides a means to measure
the isoplanatic angle. Four generations of
isoplanatic angle sensors were developed over a
two year time period. The fourth generation
device performs very well. The fact that it
provides real time information, graphically with a
one second time resolution has been particularly
useful in five SDIO field tests.

PUBLICATION: "Saturation and Zenith Angle Dependence of
Atmospheric Isoplanatic Measurements", Proceedings
of the Society of Photo-optical Instrumentation,
Engineers, April, 1985.

THESIS DIRECTED: "Remote Measurement of the Atmospheric Isoplanatic
Angle and Determination of Refractive Turbulence
profiles by Direct Inversion of the Scintillation
Amplitude Covariance function with Tiknonov
Regularization", Kurt Stevens, PhD, Physics,
December, 1985.

TITLE: Remote Atmospheric Optical Turbulence Systems

INVESTIGATORS: D. L. Walters, Associate Professor of Physics

SPONSOR: Air Force Weapons Laboratory

OBJECTIVE: To implement a fourth generation isoplanatic angle
                    instrument and develop and deliver an automated
                    atmospheric coherence length instrument.

SUMMARY: A fourth generation isoplanatic angle sensor was
                    designed in May and June and delivered to the Air
                    Force in August, 1985. This instrument collects
                    processes and displays high resolution atmospheric
                    isoplanatic angle date in real time. Test of the
                    performance of this instrument have revealed that
                    it represents a breakthrough in real time
                    atmospheric data measurements for Strategic
                    Defense Initiative programs.

                    Two of these instruments have been installed at
                    DoD locations and it is rapidly becoming the
                    standard instrument for atmospheric isoplanatic
                    angle measurements.

THESIS DIRECTED: "Remote Measurement of the Atmospheric Isoplanatic
                    Angle and Determination of Refractive Turbulence
                    Profiles by Directed Inversion of the
                    Scintillation Amplitude Covariance function with
                    Tiknonov Regularization", Kurt Stevens, PhD,
                    Physics, December 1985.

PATENT APPLICATION: To be initiated February, 1986.

DEPARTMENT

OF

ELECTRICAL AND

COMPUTER ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Introduction

The research program of the Department of Electrical and Computer Engineering involves projects in the following areas: signal processing, electromagnetics, radar and electronic warfare, communications, and computer engineering. Most projects involve thesis student efforts as indicated by the number of theses published in support of the project.

SIGNAL PROCESSING

Professor **Syd Parker** continued his work on multidimensional, nonlinear signal processing. The effort is to develop and implement algorithms to be used in the modelling, identification, and digital filtering of multidimensional, non-linear discrete-time systems.

Professor **Chin-Hwa Lee** continued his research into the implications of image segmentation on image processing. Of particular interest are the implications of being able to segment the image into pieces or arbitrary size rather than being constrained to a certain size.

Professor **Hung-Mou Lee** conducted a theoretical investigation into the non-linear differential equations used in field unification theories and was able to to present a solution for a case previously unsolved.

Professor **John Powers** continue work on image processing of holographic microscope images of combustion particles. This work seeks to reduce speckle background in the hologram reconstruction and to allow automated location and sizing of the many particles recorded in the hologram volume.

Professor **Charles Therrien** initiated study of applying multidimensional extensions of signal processing techniques to image processing. The work concentrated on extending linear predictive models and multichannel spectral estimation techniques.

Professors **Mitch Cotton**, **Rudolf Panholzer**, and **Charles Therrien** worked on emulating a multi-processor architecture that could applied to the Aegis radar system. In particular Professor Therrien investigated algorithms to provide multiple sensor distributed decision-making.

Professor **Larry Ziomek** continued work on modelling acoustic propagation in the ocean in terms linear system theory. Transfer functions for propagation and coherence functions can be derived, and by cascading transfer functions, the output of receiver array elements can be predicted for various acoustic excitations.

Professor **Sherif Michael** continued work composite operational amplifiers that are combinations of operational amplifiers that improve the speed and accuracy of the combination above that which is achieved with any of the individual op amps.

ELECTROMAGNETICS

Professor **Hung-Mou Lee** continued his work on calculating the electromagnetic fields back-scattered from a cylindrical object. This project extends scattering calculations from wire loops to the cylinder and investigates wall thickness effects.

Professor **John Powers** continued investigations in the spatial frequency domain modelling of the propagation of transient scalar waves in lossy media. This project is aimed at a computer-aided technique to predict ultrasonic waves insonifying objects as in acoustic imaging and tissue characterization.

RADAR AND ELECTRONIC WARFARE

Professor **Steven Jauregui** continued work on high frequency direction finding (HF-DF) by studying propagation conditions in the Arctic environment, measuring self-jamming on shipboard, and studying a new HF-DF system with the potential for improved performance.

Professor **Hung-Mou Lee** initiated work studying the effects of phase on determining the tracking errors of a monopulse radar system.

Professor **Hal Titus** continued work on SAM missile radar simulations and study of new SAM missile systems.

Professor **Hal Titus** and LCDR James Powell built and tested a low-cost communication jammer that has been implemented and used aboard an EA-6B aircraft in the Mediterranean.

Professor **Hal Titus** worked on designing an extended Kalman filter to enhance performance of the tracking system associated with the ESM system aboard the EA-6B.

Professor **Hal Titus** in a joint effort with members of the Physics Department worked on implementing a computer simulation of antiship missiles and to study the effects of chaff deployment against these missiles. Additional missile types are being added through student thesis efforts. Professor Titus also continued study of the performance of the Aegis radar system in the presence of chaff and active decoys to measure its vulnerability.

Professor **Hal Titus** additionally worked on an evaluation of Soviet antiship cruise missiles and comparison to US cruise missiles. The vulnerability to ECM and ECCM was studied.

COMMUNICATIONS

Professor **John Powers** continued a joint project with the Oceanography Department in the application of fiber optic data communications systems to the transmission of digital data under the ocean. The work involves design and test of working fiber optic links to meet various applications requirements. Professor Powers also continued work on a software controlled remote bit-error-rate test system for underwater application.

Professor **Steven Jauregui** continued his work on electromagnetic interference at receiving sites. The project measures inter-ference levels, deduces the source, and provides recommendations to relieve the interference.

Professor **Hal Titus** initiated work studying an adaptive phase array to be applied to the P-3C aircraft to begin a computer simulation of this array.

COMPUTER ENGINEERING

Professor **Chin-Hwa Lee** continued his work investigating algorithm development and architectural issues for computer-aided mapping applications. The application of VLSI technology and systolic array computers to mapping applications were the areas of interest in this investigation.

Professor **Larry Abbott** initiated a study of the implication of high-speed optical communications on strategic computing where limited data flow has proven to be a bottleneck. The increased data rate offered by laser transmission offers the hope for improved computer performance.

Professor **Larry Abbott** began work at NPS on the design of a fault-tolerant computer. Both the computer hardware architecture and the operating system are being designed to reduce failure. The ultimate goal of the project is to reduce the design to a VLSI design.

Professor **Donald Kirk** and Adjunct Research Professor **Herschel Loomis** conducted research in the study of automated VLSI circuit design. The goal is to compare designs produced by the MacPitts silicon compiler with custom-made designs in an effort to synergistically improve the performance of both approaches.

Professors **Don Kirk** and **Chin-Hwa Lee** performed work on providing a signal processing tutorial that emphasizes VHSIC and at studying the insertion of VHSIC technology into applications in image processing, miniaturized receivers, adaptive antenna arrays, and other military applications.

Professor **Chin-Hwa Lee** explored applications of VHSIC technology in image processing in a project performed jointly with Professor **Donald Kirk**. The parallel architecture of some VHSIC signal processing chips lends itself to image processing applications to raise computational speeds.

Professor **Harriett Rigas** studied a software system that would allow analysis and fabrication of digital circuits for implementation in VLSI.

Professors **Harriett Rigas** and **Larry Abbott** initiated a study of new computer architectures that could exploit the high data transfer rates made possible with optical communications.

SYSTEMS AND CONTROLS

Professors **Don Kirk** and **Robert Strum** continued work on studying computer-aided techniques applied to control of rolling missiles. Additionally they are working on techniques of VLSI circuit design.

Professor **Alex Gerba** continued work on the simulation of a brushless DC motor made possible by improvements in the technology of magnetic materials. The goal of the project is to provide a complete simulation of the motor to allow evaluation of its performance in the evaluation of the motor in a missile control application.

Professors **Hal Titus** and **Alex Gerba** worked on developing a Kalman tracking algorithm for a CIE-680 computer to be used in torpedo tracking on test ranges in the presence of multiple sources.

Professor **Hal Titus** worked on a project to develop microcomputer programs that would calculate optimum drop locations to achieve precision parachute delivery to desired locations for known wind conditions.

Professors **Paul Moose** and **John Wozencraft** continued their work on modelling the dynamics of combat. The mathematical models show the importance of initial conditions and intermediate equilibrium points. This work is to C^3 planners to understand the fundamental principles on the evolution of combat.

TITLE: Strategic Computing

INVESTIGATOR: Larry Abbott, Assistant Professor of Electrical
                    and Computer Engineering

SPONSOR: Naval Ocean System Center (NOSC)

OBJECTIVE: Investigates the impact of high speed serial
                    communications on strategic computing
                    architectures

SUMMARY: The investigation has shown that Laser
                    multiplexing can move data from a VLSI chip
                    through a single pin at extremely high rates.
                    Therefore, in cases where a single chip is as
                    complex or consumes as much power as possible
                    but must exchange a great deal of data with
                    similar chips, the Laser Multiplexer can
                    replace a complete interconnection chip.

TITLE: Ultra-An Ultra-Reliable Real Time Processor

INVESTIGATOR: Larry Abbott, Assistant Professor of Electrical
                         and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: The research is a continuation of research into
                         an integrated approach to system fault
                         tolerance. The approach optimizes the system
                         reliablity by simultaneously satisfying hardware
                         and software reliability requirements.

SUMMARY: In this reporting period we have completed the
                         preliminary design of the fault tolerant
                         computer and real time operating system. We
                         have completed the detailed design of the fault
                         tolerant voter and rotary multiplexer. A VLSI
                         design of the rotary multiplexer has been done.
                         We have also begun the development of
                         reliability assessment tools for evaluating the
                         analysis of fault tolerant techniques for
                         implementing the fault tolerant computer in
                         VLSI.

CONFERENCE
PRESENTATION: L. W. Abbott, "A Synergistic Fault Tolerant
                         Computer Design for an N-Version Programming
                         Environment", Nineteenth Annual Asilomar
                         Conference on Circuits, Systems, and Computers,
                         Pacific Grove, California, November 6-8, 1985.

TITLE: Simulation and Performance of Brushless DC Motor
Actuators

INVESTIGATOR: A. Gerba Jr, Associate Professor of Electrical
and Computer Engineering

SPONSOR: Naval Weapons Center, Chinahake, CA

OBJECTIVE: Development of simulation and design codes for
Brushless DC Motor Actuators. Work is in
support of WWC program "Advanced Missile Control
Devices."

SUMMARY: A CSMP language code has been developed using a
balanced bridge network model for the power
conditioner-motor system with a distributed
(sinusoidal) air-gap flux and turn-on and
turn-off dynamics for the power transistors.
Preliminary results show good agreement with
measured system performance.

THESES DIRECTED G. C. Franklin, "Computer Simulation of a Cruise
Missile Using Brushless DC Motor Fin Control,"
Master's Thesis, March 1985

M. C. Wise, "Digital Phase-Locked Loop Speed
Control for a Brushless DC Motor," Master's
Thesis, June 1985

P. M. MacMillan, "A CSMP Commutation Model for
Design Study of a Brushles DC Motor Power
Conditioner for a Cruise Missle Fin Control
Actuator," Master's Thesis, June 1985

TITLE:	Propagation of scalar acoustic waves
INVESTIGATOR(S):	Daniel Guyomar (former NRC Research Associate) and John Powers, Professor of Electrical and Computer Engineering
SPONSOR:	Unsponsored
OBJECTIVE:	To apply spatial frequency domain techniques to modeling the propagation of pulsed and transient ultrasound waves in loseless and lossy media. The technique would allow the application of computer-efficient FFT algorithms to problems that have previously used complicated line integrals for evaluation.
SUMMARY:	A linear systems approach has been identified which provides a simplified explanation of the work of the prior years. This approach relates the Green's function and the total impulse response and identifies the transfer propagation function (in the spatial frequency domain) as the two-dimensional spatial transform of the Green's function.
PUBLICATIONS:	D. Guyomar and J. Powers, "Boundary effects on transient radiation fields from vibrating surfaces", Journal of the Acoustical Society of America, 77(3), pp. 907-915, 1985
	D. Guyomar and J. Powers, "Transient fields radiated by curved surface-application to focusing", Journal of the Acoustical Society of America, 76(5), pp. 1564-1572, 1984
	D. Guyomar and J. Powers, "Transient radiation from focused transducers", Proceedings of the 1984 IEEE Ultrasonics Symposium, (IEEE Press, New York), pp. 979-982, 1984
	D. Guyomar and J. Powers, "Propagation of transient acoustic waves in lossy and lossy media", Accoustical Imaging, Vol. 14, A. Berkhout, J. Ridder, and L. Van der Waal, Eds., (Plenum Publishing, New York), pp. 521-531, 1985

D. Guyomar and J. Powers, "Transient fields from focused acoustic waves", Acoustical Imaging, Vol. 14, A . Berkhout, J. Ridder, and L. Van der Waal, Eds., (Plenum Publishing, New York), pp. 629-633, 1985

CONFERENCE
PRESENTATIONS:

D. Guyomar and J. Powers, "Influence of baffle conditions on transient radiation", 108th Meeting of the Acoustical Society of America, Minneapolis, October 1984

D. Guyomar and J. Powers, "Transient radiation from focused transducers", 1984 IEEE Ultrasonics Symposium, Dallas, November 1984

D. Guyomar and J. Powers, "Propagation of transient acoustic waves in lossy and lossy media", 14th International Symposium on Acoustical Imaging, The Hague, April 1985

D. Guyomar and J. Powers, "Transient fields from focused acoustic waves", 14th International Syumposium on Acoustical Imaging, The Hague, April 1985

Title: Noise and Interference at Receiving Sites

Investigators: S. Jauregui and W. R. Vincent, Adjunct
                     Professors of the Electrical and Computer
                     Engineering Department

Sponsor: COMNAVELEXSYS COMM

Objective: To investigate noise and interference both
                     external and internal at HF receiving sites and
                     to devise techniques to reduce that noise and
                     improve the signal to noise ratio at one site.

Summary: Vistited NSGA Edzel, Scotland twice as part of
                     the Signal to Noise Enhancement Program (SNEP)
                     made significant improvements in certain areas
                     in reduction of noise by improving cabling and
                     grounding techniques.

Conference   S. Jauregui, Radio Frequency Distribution
 Presentation: Problem Areas Signal to Noise Enhancement
                     Program, NPS, Monterey, CA 6-7 Nov. 84

Title: SIGINT/SIGSEC AND C³CM Studies

Investigator: S. Jauregui, Adjunct Professor of Electrical and
                       Computer Engineering

Sponsor: COMSPANAVWARSYS COMM

Objective: To investigate various techniques for HF signals
                       analysis and position location of targets. To
                       determine the effects of Ionospheric
                       proprogation on these techniques.

Summary: Collected data on a new automated signal
                       analysis and DF technique at Rota Spain.
                       Collected self jamming information in shipboard
                       systems aboard USS Fife. Collected data on both
                       doppler shift and line of bearing both in the
                       arctic region. Investigated a hydrid signal
                       location technique combining time difference of
                       arrival with line of bearing data for a
                       shipboard system. One fiftieth scale models
                       were used in this case.

Theses Directed: M. L. Metcalf, "A Tactical Application of
                       Differential Doppler Tracking Method," Master's
                       Thesis, March 1985.

                       L. J. Hunme, "Shipboard Electromagnetic
                       Interference and Effects on the Classic Outboard
                       System," Elec.Eng.Thesis, March 1985.

                       D. L. Avery, "The Application of Time Difference
                       of Arrival Direction Finding Techniques on
                       Outboard Equipped Ships," Master's Thesis,
                       September 1985.

                       W. R. Stark, "Investigation of Ionospheric
                       Induced Doppler Shift of High Frequency Signals
                       within the Arctic Region," Master's Thesis,
                       September 1985.

Title: Control Systems and VLSI Design Studies

Investigators: D. E. Kirk and R. D. Strum, Professors of
                    Electrical and Computer Engineering

Sponsor: Strategic Systems Project Office

Objective: To develop computer-aided techniques and apply
                    them to problems of interest in development of
                    missile control system, and to develop VLSI
                    design tools with application to structures for
                    high-speed digital filters.

Summary: Work began on a control design for a rolling
                    missile. The goal was to compensate for the
                    coupling produced among the rotational motions
                    when roll motion occurs. This phase of the
                    project will be completed in Q1 of FY'85. An
                    initial custom VLSI design of a CMOS 16-bit
                    pipelined adder has been completed and chip has
                    been fabricated though DARPA's MOSIS facility.
                    Testing of the chip awaits acquisition of test
                    equipment.

Publication: Design of a Sixteen-Bit Pipelined Added Using
                    CMOS Bulk P-Well Technology, MSEE Thesis, W. R.
                    Reid, December 1984.

TITLE: VLSI Circuit Design - A Silicon Compiler
Approach

INVESTIGATORS: D. E. Kirk, Professor of Electrical and Computer
Engineering, H. H. Loomis, Jr. Adjunct Professor
of Electrical and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To utilize the MacPitts silicon compiler to
investigate architectural alternatives for
signal processing operations, including making
comparisons between the circuits generated and
those obtained by a hand-crafted approach, and
to enhance the capabilities of MacPitts.

SUMMARY: Four designs have been completed, two designs of
a 16-bit pipeline adder and two designs of a
piplined multiplier (one 8-bit and one 16-bit).
Two of these designs were obtained by a custom
approach using computer-aided design tools
whereas the other two designs were obtained by
using MacPitts. Comparisons indicate that the
MacPitts designs are somewhat slower, and less
dense, but not so much as to make this approach
infeasible. As a result of these comparisons,
several areas for improvement have been
indicated and efforts are continuing to
implement appropriate modifications.

PUBLICATION: VSLI Design Using a Silicon Compiler
Approach, D. E. Kirk and H. H. Loomis, Jr.
NPS Technical Report, in progress.

THESES DIRECTED: Silicon Compiler Design of Combinational and
Pipeline Adder Integrated Circuits, MSEE
Thesis, A. O. Fioede III, June 1985.

VSLI Design with the MacPitts Silicon
Compiler/R. C. Larrabbee, MSEE Thesis, Sept.
1985.

VLSI Design of a Sixteen Bit Pipelined
Multiplier Using Three Micron NMOS
Technology, MSEE Thesis, R.J. Simchik, Jr.,
June 1985.

175

TITLE: VHSIC Design Methodology & System Applications

INVESTIGATORS: D. E. Kirk, Professor of Electrical and Computer
                          Engineering , C-H Lee, Associate Professor of
                          Electrical and Computer Engineering

SPONSOR: Naval Ocean Systems Center, Code 9404

OBJECTIVE: To develop a signal processing tutorial for
                          presentation at a VHSIC Insertion workshop.

                          To carry out design studies on the use of
                          VHSIC technology in the areas of image
                          processing, adaptive antenna arrays,
                          miniaturized receivers and hardware
                          executive modules.

SUMMARY: The signal processing tutorial, except for
                          production of audio-visual materials, has been
                          completed. The design studies are progressing
                          as scheduled. Several computer simulation aids
                          have been installed and used to evaluate
                          VHSIC-based designs. The design of a systolic
                          array for adaptive antenna arrays has been
                          completed, and initial results indicate the
                          benefits of using a content-addressable memory
                          (CAM) chip in tactical image processing
                          applications.

PUBLICATION: Similarity Counting Architecture for Object
                          Detection, C-H Lee, to be submitted to 13th
                          International Symposium on Computer
                          Architecture.

TITLE: VHSIC Design Methodology and Systems
                    Applications, VHSIC insertion in Tactical Image
                    Processing

INVESTIGATORS: D. E. Kirk and C. H. Lee, Associate Professors,
                    Department of Electrical and Computer
                    Engineering

SPONSOR: Naval Ocean System Center

OBJECTIVE: To develop new design methodology to use VHSIC
                    chips in system application

SUMMARY: The goal is to construct a parallel architecture
                    using VHSIC chips to execute the segmentation
                    operations. It is intended to use the existing
                    phase 1 chips such as the high speed ALU, high
                    speed memory multiplexer, and microprogrammable
                    controller in a special design with parallel
                    configuration. The problems related to signal
                    timing and electrical interfacing of these chips
                    will be studied in the CAD simulation
                    environment.

PUBLICATION: P. Cody, "Implementation of Image segmentation
                    on Military 175 & A architecture," M.S. thesis
                    in press.

TITLE:	Advance Algorithm and Architecture for Digital Mapping
INVESTIGATOR:	C. H. Lee, Associate Professor, Department of Electrical and Computer Engineering
SPONSOR:	Headquarter of Defense Mapping Agency
OBJECTIVE:	To explore the advance algorithms and architectures to support the ever expanding demands of the digital mapping in the defense Mapping Agency
SUMMARY:	There have been rapid improvements in digital electronics and computer technology in recent years. Among the many developments the following two trends have yielded successful results and proved to be maturing. The very large scale integrated (VLSI) circuit helps to improve the performance of the digital computer and reduce its costs. The design methodology offers many alternatives to use VLSI circuits so that it is not restricted to special groups with large volume needs. The other trend is to explore new algorithms and architecture so that parallel or pipeline implementations of a system help to increase the processing power. It is beneficial to apply these techniques to the unique demanding problems in digital mapping. A number of specific problems are studied.
PUBLICATIONS:	J. D. Bloomquist, "Hierarchical Image Segmentation to Infrared Images," Master Thesis, June, 1985

L. Sonya and Chin-Hwa Lee, "Fundamentals of Systolic Array Computers," Naval Postgraduate School, Technical Report, NPS-62-84-065 |

TITLE: Image Processing Research

INVESTIGATOR: Chin-Hwa Lee, Associate Profesor, Department of
                  Electrical and Computer Engineering

SPONSOR: Naval Electronic System Command

OBJECTIVE: To address both computer analysis and hardware
                  implementation aspects of image processing using
                  concise spatial features of irregular piecewise
                  polynomial surfaces.

SUMMARY: In traditional signal analysis theory, the
                  signal is treated as samples over regular
                  intervals either in time or in space. In
                  digital image processing this approach involves
                  large volume of data which is proportional to N^2
                  where N is the size of the image frame. There
                  is a strong incentive to keep only relevant
                  subset samples of this large array, which
                  contains essential information of the original
                  image. In other words, it is advantageous to
                  represent the image signal in terms of irregular
                  space samples so that the total amount of data
                  is small. This work studies the implication and
                  problems associated with this kind of approach.

PUBLICATION: C. H. Lee, "Image Surface Approximation with
                  Irregular Samples," Submitted to IEEE
                  transaction on Pattern Analysis and Machine
                  Intelligence for publication.

TITLE:	Finite Cylinder Scattering
INVESTIGATOR:	Hung-Mou Lee, Assistant Professor of Electrical and Computer Engineering
SPONSOR:	Office of Naval Research
OBJECTIVE:	To investigate theoretically and experimentally the back scattered field from a tubular cylinder and to explore possible applications of the research findings to more complicated targets.
SUMMARY:	Accurate head-on scattering data were obtained and confirmed theoretical predictions. Coupling between internal and external modes of the tubular cylinder was observed. It was concluded that the wall thickness can be neglected in thetheory while the choice of the diameter of the cylinder was very important because the inner diameter of the cylinder determined the waveguide modes. When fins were added to the cylinder, its head-on back scattering cross section was increased while its broadside scattering cross section was reduced. This phenomenon should be studied further.
PUBLICATION:	H. M. Lee, G. P. Chung, D. Geller and P. Haklay, The H 11 Circular Waveguide Mode and the Back Scattering Cross Section along the Axis of a Thin Walled Tubular Cylinder of Finite Length," paper submitted to IEE proceedings, Part H.
CONFERENCE PRESENTATION:	H. M. Lee, D. Geller, B. Haklay, A. Setiawan and G. P. Chung, "Back Scattering Cross Section along the Axis of a Tubular Cylinder of Finite Length," presented at the International Symposium of Antennas and Propagation, Japan at Kyoto, Japan, August 1985.
THESES DIRECTED:	M. Loric, "Radar Target Identification through Electromagnetic Scattering Studies," Master's Thesis, December 1984.
	B. Haklay, "Broadside Scattering of a Tubular Cylinder for Evaluation of Target Identification," Master's Thesis, March 1985.
	D. Geller, "Head-On Scattering of a Tubular Cylinder of Finite Length for Radar Target

Identification Purposes," _Master's Thesis_, March 1985.

G. P. Chung, "Effects of Waveguide Modes on the Scattering of a Tubular Cylinder," _Master's Thesis_, September 1985

TITLE:	Inherent Tracking Errors of a Monopulse Radar
INVESTIGATOR:	Hung-Mou Lee, Assistant Professor of Electrical and Computer Engineering
SPONSOR:	NPS Foundation Research Program
OBJECTIVE:	To study the inherent angular tracking errors of monopulse radars and to develop, based on the findings of this study, countermeasures against this type of radars.
SUMMARY:	A radar is designed for tracking a point target but is always used for tracking a complex target. This will result in errors in the estimated target location by the radar. This type of errors has been discussed over the previous 25 years without its origin being recognized. Related problems have been over-simplified and journal publications have been infested with erroneous claims. This research is intended to point out the inadequacies in previous work and to lay the foundation for future developments in this area.
THESES DIRECTED:	Dae Hyun Park, "Inherent Tracking Error in an Amplitude Comparison Monopulse Radar," Master's Thesis, December 1984.
	Sopon Bumroongpol, "Angular Tracking Error in a Phase Comparison Monopulse Radar: A Critical Review and Extension of the Phase Front Distortion Approach," Master's Thesis, December 1984

TITLE: Studies in Non-Linear Problems

INVESTIGATOR: Hung-Mou Lee, Assistant Professor of Electrical and Computer Engineering

OBJECTIVE: To study problems involving integrable non-linear systems such as those encountered in grand unification theories and those leading to soliton solutions.

SUMMARY: A system of non-linear partial differential equations encountered in five dimensional gravitation theory was integrated. This led to massive solutions for dyons and represented a step forward in efforts to achieve the unification of gravitational and eletromagnetic forces through a higher dimensional space-time structure.

PUBLICATION: H. M. Lee and S. C. Lee, "Spherically Symmetric Kaluza-Klein Monopoles," Physics Letters, 149B, 95-97, December 1984.

TITLE: High-Speed, High-Accuracy Integrated Operational
                          Amplifiers

Investigator: Sherif Michael, Assistant Professor of
                          Electrical and Computer Engineering

Sponsor: Foundation Research Activity

Objective: To develop high-speed, high-accuracy integrated
                          operational amplifiers using the composite
                          operational amplifier techniques previously
                          proposed by the reseacher. One major goal of
                          the research was to develop a micro and a
                          macro-computer-model of the different
                          operational amplifiers to be used in designing
                          and evaluating the new composite amplifier.

Summary: An intensive survey of currently available
                          state-of-the-art technology for designing fast,
                          accurate operational amplifiers (op amps) was
                          completed. Based on the result of that survey,
                          it was found that using the composite amplifier
                          approach would yield the best results. The
                          research examines and discusses the feasibility
                          of utilizing composite op amps to overcome the
                          inherent inability of the IC op amps to
                          simultaneously perform in a very fast, very
                          accurate mode. The novel designs developed were
                          also found to provide enhanced stability,
                          decreased sensitivity to circuit element
                          variations and significant extension in
                          bandwidth. Computer simulations of the
                          constructed op amps using the two developed
                          micro and macro models were found to be
                          agreeable to the extensive experimental results.
                          Results in both linear and non-linear
                          applications were demonstrated. These optimum
                          novel designs not only offer significantly
                          improved AC and DC performance over currently
                          available devices, but also make no new demands
                          on technology, since they only require the
                          devices that can be produced with currently
                          available linear monolithic techniques.

Publications: S. Michael and P. Gariano, "Micro and
                          Macromodeling of Integrated Operational
                          Amplifiers and Their Use in Developing and
                          Evaluating New Composite Op Amps," Proceedings
                          of Midwest Symposium on Circuits and Systems,
                          Louisville, KY., August 1985.

184

S. Michael and P. Gariano, "Optimization of High-Speed, High-Accuracy Integrated Operational Amplifiers," Proceedings of Midwest Symposium on Circuits and Systems, Louisville, KY., August 1985.

S. Michael and P. Gariano, "Application of Precision, High-Slew Rate Op Amps in Active Networks," Proceedings of Midwest Symposium on Circuits and Systems, Louisville, KY, August 1985.

Conference
Presentation:

S. Michael, "Micro and Macromodeling of Integrated Operational Amplifiers and Their Use in Developing and Evaluating New Composite Op Amps," Midwest Symposium on Circuits and Systems, Louisville, KY, August 1985.

S. Michael, "Application of Precision, High-Slew Rate Op Amps in Active Networks," Midwest Symposium on Circuits and Systems, Louisville, KY, August 1985.

Theses Directed:

A. Luczak, "Composite Operational Amplifiers and Their Use in Improving Bandwidth, Speed and Accuracy in Active Networks," Master's Thesis, June 1985.

P. Gariano Jr., "Generation of an Optimum High Speed, High Accuracy Operational Amplifier," Master's Thesis, September 1985.

Title: Dynamic State Model of Combat

Investigators: P.H. Moose, Associate Professor of Electrical and
                          Computer Engineering, and J.M. Wozencraft, Dist-
                          inguished Professor of Electrical and Computer
                          Engineering

Sponsor: Joint Director of Laboratories via NOSC, San
                          Diego, CA.

Objective: To develop an analytical dynamic state model of
                          attrition for multi-species military forces.

Summary: In this research we have studied the dynamical
                          properties of a system of generalized Lanchester
                          equations. The principal finding of our
                          research is that their behavior in the aggregate
                          is closely determined by initial conditions and
                          a few important geometrical features in the
                          state space. These are the equilibrium points
                          of the system, along with their dominant
                          eigenvalue and eigenvectors, and the asymptotes.
                          Methods have been developed to find these
                          features and tested for 2X2 systems. Given
                          these features, one can find a characteristic
                          aggregate trajectory toward which all
                          trajectories are attracted. Once near this
                          characteristic trajectory, evolution continues
                          along it either toward an equilibrium point that
                          is stable or away from an equilibrium point that
                          is unstable. If there are no equilibrium points
                          in the direction of travel, then evolution is
                          toward an asymptote. However, since the
                          asymptotes are always negative, zero values will
                          be reached for one or more of the state
                          variables as the asymptote is approached. Since
                          the state variables represent quantities of
                          resources, evolution must be modified on
                          approaching the boundaries of the positive
                          quadrant. We have developed a means to
                          terminate the trajectories at the boundaries
                          with minimal alteration to their properties
                          interior to the positive quadrant. Perhaps one
                          of the most important results of our research is
                          a technique to map NxM systems of Lanchester
                          equations into equivalent 1X1 systems.

Conference   P. H. Moose, "Asymptotic Trajectories of
Presentation :   Generalized Lanchester Equations", NPS/CEMA
                          Conference on Combat Modeling, May 2-3, 1985,
                          Monterey, CA

TITLE: Solid Propellant Combustion

INVESTIGATOR(S):   David Netzer, Professor of Aeronautics, and John
                     Powers, Professor of Electrical and Computer
                     Engineering

SPONSOR: Air Force Rocket Propulsion Laboratory

OBJECTIVE: To conduct an experimental investigation of the
                     effects of solid propellant properties and motor
                     operating conditions on metallized particulates
                     within the combustor and exhaust nozzle. The
                     techniques investigated are: high speed motion
                     pictures, light scattering, scanning electron
                     microscopy, and optical holography. This report
                     is on efforts to provide automatic data
                     reduction from holograms of the particulates.

SUMMARY: A Quantimet 720 image processing system was
                     interfaced with a PDP 11/04 computer controller
                     for the purpose of automating the particle
                     sizing and locating operation. Hardware and
                     software problems in the Quantimet system were
                     identified and repaired. Preliminary test
                     results were obtained from a calibration
                     target illuminated with white light. Hologram
                     images of the calibration target and actual
                     particles in the rocket motor were studied, but
                     increased contrast is required to successfully
                     use the holograms. A PC/AT image processing
                     system was identified and purchased to allow
                     investigation of contrast enhancement techniques
                     and smoothing algorithms to suppress speckle
                     effects in the hologram reconstructions.

PUBLICATIONS: D. Netzer, J. Powers, J. Glenn, K. Graham, R.
                     Harris, and Y. Lee, "Solid propellant combustion
                     diagnostics and automated data retrieval from
                     holograms", Proceedings of the 21st JANNAF
                     Combustion Meeting, forthcoming

                     D. Netzer and J. Powers, "Particle sizing in
                     rocket motor studies utilizing hologram image
                     processing", Proceedings of the Workshop on
                     Automated Data Reduction from Images and
                     Holograms, (NASA Ames Research Center, Mountain
                     View, CA), forthcoming

187
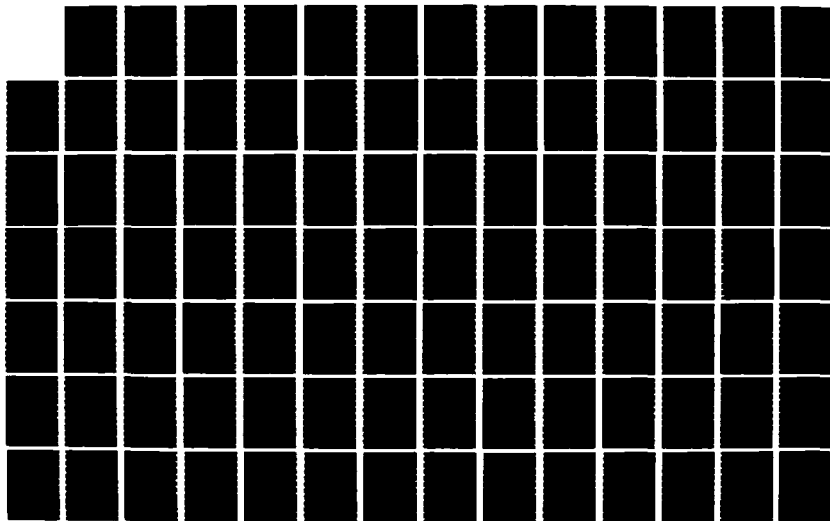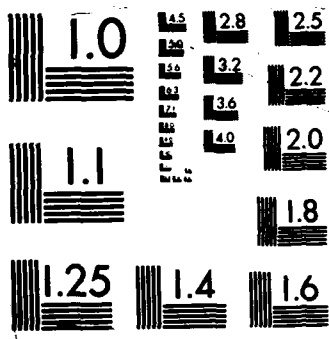
CONFERENCE PRESENTATIONS:	D. Netzer, J. Powers, J. Glenn, K. Graham, R. Harris, and Y. Lee, "Solid propellant combustion diagnostics and automated data retrieval from holograms", 21st JANNAF Combustion Meeting, Laurel, MD, October 1984
	D. Netzer and J. Powers, "Particle sizing in rocket motor studies utilizing hologram image processing", Workshop on Automated Data Reduction from Images and Holograms, Mountain View, CA, January 1985
	D. Netzer and J. Powers, "Experimental techniques for obtaining particle behavior in solid propellant combustion", AGARD Specialists Meeting on Smokeless Propellants, Florence, Italy, September 1985
THESIS DIRECTED:	LT P. M. Shook, "Computer-controlled image analysis of solid propellant combustion holograms using a Quantimet 720 and a PDP-11", Master's Thesis, September 1985

TITLE: Discrete Time Multidimensional and Nonlinear
                        Signal Processing For Modeling and Filtering

INVESTIGATOR: S. R. Parker, Professor, Department of
                        Electrical and Computer Engineering

SPONSOR: Office of Naval Research

OBJECTIVE: This is part of a continuing program. Research
                        in the development and implementation of
                        algorithms for multidimensional and nonlinear
                        discrete time signal processing for purposes of
                        system modeling, identification, and digital
                        filtering.

SUMMARY: Existing lattice algorithms have been
                        reformulated in a tensor framework leading to a
                        family of orthogonal lattice configurations
                        which grow in dimension along the cascade.
                        These have been applied to the 2-D
                        autoregressive and the nonlinear modelling
                        problem. A non-orthogonal four-field lattice
                        configuration, which requires two magnitudes
                        fewer computations and contains simple stability
                        conditions for recursive models, has also been
                        developed. Their properties in terms of
                        complexity, approximate orthogonality, and
                        stability are being considered.

PUBLICATIONS: H. Lev-Ari and S. R. Parker, "Lattice-Filter
                        Modeling of Two Dimensional Fields" Proceedings
                        of the IEEE International Conference on
                        Acoustics, Speech, and Signal Processing.
                        Tampa, Florida, March 1985, pp. 1317-1320.

                        B. B. Madan and S. R. Parker, "Adaptive Beam
                        Forming in a Correlated Interference
                        Environment" Proceedings of the IEEE
                        International Conference on Acoustics, Speech,
                        and Signal Processing, Tampa, Florida, Marach
                        1985.

                        S. R. Parker and P. J. Lenk, "Tensor Formulation
                        for the Modeling of Discrete-Time Nonlinear
                        System" Proceedings of the IEEE International
                        Symposium on Circuits and Systems" Kyoto, Japan,
                        June 1985.

                        S. R. Parker, A. H. Karjran, E. Dokanakogln,

"Assymetric Half-Plane Modeling of 2-D Fields Using Lattice Structures" Proceedings of the IEEE International Symposium on Circuits and Systems, Kyoto, Japan, June 1985.

S. R. Parker, "Discrete Time Lattice Parameter Modeling and Filtering" Proceedings of the China 1985 International Conference on Circuits and Systems, Beijing, China, June 1985

B. B. Madan, S. R. Parker and M. Zubair, "Systolic Array Structure for Least Square Problems" Proceedings of the IASTED International Symposium on Applied Signal Processing and Digital Filtering, Paris, France, June 1985.

Y. C. Lim and S. R. Parker "JOn the Identification of Systems from Data Measurements Using Lattice Models" IEEE Transactions on Acoustics, Speech, and Signal Processing, forthcoming

J. J. Thomas and S. R. Parker "Implementing Exact Calculations in Hardware" IEEE Transactions on Computers, forthcoming

B. B. Madan and J. J. Thomas " A Highly Efficient Recursive Digital Filter Using Single-Modulus Prime Residue Arithmetic" IEEE Transactions on Circuits and Systems and the IEEE Journal on Solid State Circuits, forthcoming

H. Lev-Ari, P. Lenk, and S. R. Parker "Orthogonal Two-Dimensional Lattice Models", forthcoming

H. Lev-Ari and S. R. Parker "Stable and Efficient Two-Dimensional Lattice Models", forthcoming

H. Lev-Ari and S. R. Parker "Multidimensional Maximum-Entropy Covariance Extension" to be submitted to IEEE Trans. Acoust. Speech and Signal Processing, forthcoming

B. Madan and S. R. Parker "Adaptive Array in a Correlated Noise Environment", forthcoming

190

P. Lenk and S. R. Parker "Escalator Structure for Modeling 2-D Fields", forthcoming

P. Lenk and S. R. Parker "Orthogonal Lattice Filters for Nonlinear Modeling", forthcoming

P. Lenk, B. Madan and S. R. Parker "Systolic Implementation of 2-D Orthogonal Lattice Structures", forthcoming

CONFERENCE
PRESENTATION
Presentation on "Maximum Entropy 2-D Signal Analysis and Modeling" Maximum Entropy Conference and Workshop - (ONR sponsored). University of Wyoming, Laramie, Wyoming, August 1985.

THESES DIRECTED
E. Dokanakoglu, "Half Plane Lattice Modeling with Six Reflection Factors", Master's Thesis, December 1984.

G. Bayramoglu, "2-D Lattice Modeling Applied to Image Processing", Master's Thesis, December 1984.

D. Bozkurt, "2-D Lattice Modeling for Image Coding", Master's Thesis, March 1984.

D. W. Jordan, "A Matched Filter for Acoustic Sig. Detection", Master's Thesis, June 1985.

P. J. Lenk, "Tensor Formulations for the Modelling of Discrete Time Nonlinear and Multidimensional Systems", Doctoral Thesis, September 1985.

TITLE:	Fiber optics in underwater range applications
INVESTIGATOR:	John Powers, Professor of Electrical and Computer Engineering
SPONSOR:	Naval Underwater Warfare Engineering Station
OBJECTIVE:	To investigate and develop techniques of transmitting data through underwater fiber optic cables

SUMMARY: A remote bit-error-rate fiber optic test system was designed and tested. The tester is controlled through a low-power CMOS microprocessor that has preprogrammed instructions containing the test sequence and the time increment for testing. The device was successfully built and tested in a laboratory environment. The system has sufficient memory for 621 tests. The data rate is limited to 5MHz by the clock of the microprocessor. Higher data rates are possible with alternative devices. A duplicate board is being fabricated for NUWES use. Techniques for increasing the data rate-bandwidth product are under investigation using a correlator rather than a digital gate to perform the comparison.

Title: Computer-Aided Design of Digital Systems

Investigator: H. B. Rigas, Professor and Chairman of
                    Electrical and Computer Engineering

Sponsor: Exxon (Washington State University)

Objective: To develop a unified environment of digital
                    systems.

Summary: A software system is being developed to provide
                    a complete design environment for the analysis
                    and fabrication of digital systems. The first
                    phase of the project has resulted in the
                    completion of an efficient hierarchical logic
                    simulator and the specification of a Hardware
                    Design Language which is compatible with C. The
                    results cf hardware specification can drive VLSI
                    logic layout programs of PC board layouts.

Publications: A. Mahmood, H. B. Rigas, "An Efficient and
                    Extensible Multi-Level Logic Simulator," in
                    progress.

Thesis Directed: A. Mahmood, "Design of a Multi-Level Logic
                    Simulator for VLSI Systems," Ph.D Thesis, August
                    1985.

Title:	Visit to Japan to Attend Fifth-Generation Meetings and Visit Laboratories
Investigator:	H. B. Rigas, Professor and Chairman of Electrical and Computer Engineering
Sponsor:	National Science Foundation
Objective:	To recommend research directions for NSF based on current Japanese developments.
Summary:	A team of researchers under the leadership of the PI visited several laboratories in Japan and attended the Fifth Generation Computer Conference in Tokyo. A report to NSF outlined important research issues for US attention. A second trip to Japan and one to the UK will take place in 1985 to follow up on findings and recommend further studies.
Publications:	H. B. Rigas, et.al., "Artificial Intelligence Research in Japan," Computer, Vol. 18, No. 9, September 1985, pp. 83-90.
Conference Presentation:	H. B. Rigas, "The Fifth Generation Computer Systems Projects," Invited Panelist, 12th annual International Symposium on Computer Architecture. June 18, 1985.

TITLE: Aegis System Research

INVESTIGATORS: H. Titus, R. Panholzer and M. Cotton, Professors
                    in Electrical and Computer Engineering
                    Department. U. Kodres, Professor of Computer
                    Science

SPONSOR: Navy Sea System Command

OBJECTIVE: To conduct studies in adaptive tracking in an
                    ECM environment

SUMMARY: Studies were involved in investigating the
                    interplay of chaff and active decoys used in
                    consort with the Aegis system. In this regard
                    the interplay via micro-computers with the Aegis
                    system for aiding and point defense was
                    investigated.

195

TITLE: Common Filtering for Real Time Torpedo Tracking

INVESTIGATORS: H. Titus and A. Gerba, Professors of Electrical
                    and Computer Engineering

SPONSOR: Navy Undersea Warfare Engineering Station
                    (NUWES)

OBJECTIVE: To develop a real time common filter tracking
                    algorithm for the torpedo range.

SUMMARY: An extended Kalman filter program was developed
                    and designed to track torpedos via the four
                    hydrophone array that exists on one mile centers
                    in the torpedo ranges associated with the
                    Keyport facility. The program was developed to
                    run on the range computers which are a CIE-680
                    system utilizing sea language.

TITLE:	EA6B Update
INVESTIGATOR:	H. Titus, Professor of Electrical and Computer Engineering
SPONSOR:	Pacific Missile Test Center
OBJECTIVE:	To apply extended Kalman Filter tracking techniques to the bearing only observations for an update to the EA6N ESM system.
SUMMARY:	Previously the EA6B systems had very marginal capability in giving good angle information on eminations from enemy radar. The new system coming into the fleet will provide great improvements in this area, making it possible to provide a real time locating and tracking technique for emitters.

TITLE:	Evaluation Simulation and Analysis for the Crossbow Committee
INVESTIGATOR:	H. Titus, Professor of Electrical and Computer Engineering
SPONSOR:	Navy Weapons Center, China Lake
OBJECTIVE:	Evaluation, simulation and analysis of Soviet missiles/radars.
SUMMARY:	Missile radar simulations in an ECM environment are under way. The Soviet SA10, SA11 and SA12 were simulated. The latest developments in Soviet missilery were studied.

TITLE: Investigation of the Adaptive Control Phase to
                      Array System to be Installed in the P3C Update
                      Aircraft

INVESTIGATOR: H. Titus, Professor of Electrical and Computer
                      Engineering

SPONSOR: Naval Air Development Center

OBJECTIVE: To conduct an investigation with regard to the
                      direction of arrival capability of the adaptive
                      control of the phase array system to be
                      installed in the P3C update aircraft.

SUMMARY: An investigation was made of the adaptive phase
                      array system and a simulation was undertaken on
                      this system.

TITLE: NATO SEA GNAT Development Program

INVESTIGATORS: H. Titus, Professor of Electrical and Computer
                    Engineering, A.W. Cooper and J. Crittenden,
                    Professors of Physics

SPONSOR: Space and Naval Warfare System Command

OPJECTIVE: To develop optimum strategies for the deployment
                    of the NATO SEA GNAT chaff against Soviet
                    Antiship cruise missiles.

SUMMARY: Very large scale simulation was obtained from
                    NRL and converted for use in the C^3 Lab Computer.
                    Simulations were undertaken on several of the
                    latest Soviet cruise missiles and studies were
                    undertaken regarding he optimum chaff deployment
                    against these missiles. Several other students
                    worked independently in developing cruise
                    missile simulation programs and radar and
                    electronic warfare programs to aid in this
                    research.

TITLE: Soviet Antiship Cruise Missiles

INVESTIGATOR: H. Titus, Professor of Electrical and Computer
                        Engineering

SPONSOR: Naval Intelligence Support Center

OBJECTIVE: Study the latest developments in Soviet Antiship
                        cruise missiles and ways for defeating them.

SUMMARY: An evaluation was made of Soviet Antiship cruise
                        missiles and the study of soviet techniques
                        encountering our cruise missile was investigated.
                        Pertinent techniques in ECM and ECCM applicable
                        to Soviet ASCM were investigated.

TITLE: Study and Evaluation of a Miniaturized GPS System
                          with a Guidance Package for Use by Parachutists to
                          Guide them to a Landing Area

INVESTIGATOR: H. Titus, Professor of Electrical and Computer
                          Engineering

SPONSOP: Naval Ocean Systems Center

OBJECTIVE: To develop a optimum control procedure for a
                          parachutist to drop from 30,000 feet altitude to
                          a precise location given varying wind conditions
                          at different altitudes.

SUMMARY: Computer programs were written on the mainframe
                          computer and on the microcomputer to determine
                          optimum launch points for parachutists given an
                          objective drop point and the local wind
                          conditions from the Fleet Numerical Weather
                          Facility. In addition, a control point was
                          given to optimally steer the parachutist at
                          various altitudes from his drop point.

TITLE:	Tactical Communications Jamming
INVESTIGATOR:	H. Titus, Professor of Electrical and Computer Engineering
SPONSOR:	Naval Air Test Center
OBJECTIVE:	To design a low cost communication jammer using state of the air equipment.
SUMMARY:	A low cost communications jammer was designed, built and tested as a interim device for a new system which should come to the fleet in early 1990. The communications jammer was built and tested at the Navy Weapons Center in China Lake. The system is presently already operational in the EA6B aircraft and was recently used in the Mediterranean area.

TITLE: Vector-Valued Image Processing

INVESTIGATOR: C. W. Therrien, Associate Professor of
                      Electrical and Computer Engineering

SPONSOR: NPS Foundation Research Program

OBJECTIVE: To explore the use of multichannel signal models
                      for the analysis of color images and other
                      multiple frequency band sets of images.

SUMMARY: Work was begun on developing multichannel two
                      dimensional (2-D) signal models for images. The
                      research focused on linear predictive (all-pole)
                      models. Several important relations linking
                      multichannel images to other multidimensional
                      signals were discovered. An algorithm based on
                      the models to segment color images was developed.
                      Work was begun on multichannel 2-D spectral
                      estimation. This work seeks to develop
                      model-based high resolution methods for the
                      estimation of spectra and cross spectra in 2-D

PUBLICATION: C. W. Therrien, "Multichannel Filtering Methods
                      for Color Image Segmentation," Proc. IEEE Comp.
                      Soc. Conf. on Computer Vision and Pattern
                      Recognition, 19-23 July 1985, San Francisco

TITLE:	Underwater Acoustic Propagation and Scattering in a Random Ocean - A Linear Systems Theory Approach
INVESTIGATOR:	L. J. Ziomek, Assistant Professor of Electrical and Computer Engineering
SPONSOR:	DARPA
OBJECTIVE:	To derive transfer functions and coherence functions of the random ocean medium based on the WKB and parabolic equation approximations. By coupling the transfer functions to various transmit signals and transmit and receive apertures, problems in pulse propagation, underwater acoustic communication, and target detection will be studied via computer simulation of the derived mathematical expressions.
SUMMARY:	Computer simulation of the equations for the output electrical signals at <u>each</u> element in a receive planar array of complex weighted point sources in terms of the frequency spectrum of the transmitted electrical signal, the transmit and receive arrays, and the transfer function of the ocean medium based on the WKB approximation has been completed. A three-dimensional FFT beamformer space-time signal processing algorithm was used to process the computer simulated signals in order to study problems in source localization, underwater acoustic communication, and target detection. Work began on frequency domain adaptive beamforming.
PUBLICATIONS:	L. J. Ziomek and J. Vos, "Linear Time-Invariant Space-Variant Filters and the WKB Approximation," Proc. 1985 IEEE Int. Conf. Acoust., Speech, Signal Processing, Vol. 1, 184-187, March 26-29, 1985, Tampa, FL.
	L. J. Ziomek, "Linear Time-Invariant Space-Variant Filters and the Parabolic Equation Approximation," Signal Processing, Vol. 8, No. 4, 423-439, 1985.
THESES DIRECTED:	Jan Vos, Linear Time-Invariant Space-Variant

Filters and the WKB Approximation with

Applications to Underwater Acoustic Signal
Processing, Master of Science in Engineering
Acoustics, December 1984.

Richard J. Blount, Jr., Underwater Acoustic
Model-Based Signal Processing Applied to the
Detection of Signals from a Planar Array of
Point Source Elements, Master of Science in
Electrical Engineering, September 1985.

DEPARTMENT

OF

METEOROLOGY

DEPARTMENT OF METEOROLOGY

The research program in the Department of Meteorology continues in several areas: (1) numerical air/ocean modeling and prediction, (2) dynamics of flow over and around mountains, (3) analysis and dynamics of tropical weather systems, (4) atmospheric boundary layers over the sea and ice, (5) forecasting marine air/ocean parameters using model output statistics, (6) regional weather studies and (7) satellite remote sensing. A number of related investigations have been pursued by various faculty members under each of these headings.

NUMERICAL MODELING AND PREDICTION

R. T. Williams is developing and testing numerical procedures for global and regional weather prediction. He is investigating various finite element formulations with respect to treatment of small-scale flow fields. He will apply the techniques to the prediction of air flow near mountains and to tropical cyclones. R. T. Williams and M. A. Rennick are studying topographic effects and the behavior of planetary waves with a spectral baroclinic model. L. C. Chou, R. T. Williams and C.-P. Chang are investigating the "Mei-Yu" rains in China with a moist frontal model.

R. L. Elsberry, D. Adamec and L. K. Shay are using a three-dimensional ocean model to simulate the response to passage of a hurricane. The present focus is on understanding the response to more realistic wind distributions and initial ocean conditions.

Numerical-observational studies of rapid maritime cyclogenesis events are being pursued by R. L. Elsberry, C.-S. Liou and C. H. Wash. Diagnostic studies of analysis and predictions by the Naval Operational Regional Atmospheric Prediction System are used to evaluate physical processes that occur during rapid cyclogenesis.

Other modeling efforts include (1) a dynamical-statistical model for predicting the movement of tropical cyclones, led by R. L. Elsberry, (2) a marine atmospheric boundary layer model for predicting (6-12 hours) properties which affect radar and optical propagation within the boundary layer and those factors (radiation and boundary fluxes) which affect the upper part of the ocean, directed by K. L. Davidson, (3) a numerical investigation of the dynamics of synoptic-scale variability in the California Current, led by R. L. Haney and (4) a study on the impact and methods of coupling an ocean mixed-layer model to an atmospheric prediction system (R. L. Elsberry and C.-S. Liou).

DYNAMICS OF FLOW OVER AND AROUND MOUNTAINS

R. T. Williams and M. A. Rennick are studying the conditions which determine whether or not the air will flow over or around a long mountain range. The formulation of cyclones in the lee of mountain complexes is being investigated. Also, the interaction of fronts with topography is being considered.

ANALYSIS AND DYNAMICS OF TROPICAL WEATHER SYSTEMS

C.-P. Chang, R. L. Elsberry, R. T. Williams and M. S. Peng continue to investigate various aspects of the dynamics of tropical weather systems, including development of hurricanes and typhoons by R. L. Elsberry, the dynamics of tropical synoptic and planetary scale motions and lateral interactions by C.-P. Chang , R. T. Williams and M. S. Peng, and the diagnostic analysis of winter and summer monsoon circulations by C.-P. Chang and M. S. Peng. C.-P. Chang and J. S. Boyle also studied the interannual variations of tropical circulations using a ten-year global data base. M. A. Rennick and R. L. Haney are investigating mechanisms of large-scale air-sea interaction in the tropics using coupled numerical models. The work concentrates on ocean temperature and atmospheric circulaton anomalies associated with El Nino.

MARINE ATMOSPHERIC BOUNDARY LAYERS OVER THE SEA AND ICE

Research in the area includes several interdisciplinary shipboard and land-based observational and theoretical projects involving K. L. Davidson and W. J. Shaw. Recent observational projects have occurred in the Marginal Ice Zone of the East Greeland Sea and in the Santa Barbara Channel of Southern California. Objectives of the individual projects are: (1) to evaluate and formulate models which relate changes in the depth and structure of the atmospheric boundary layer to surface fluxes and sky conditions, (2) to evaluate and formulate models for equilibrium marine aerosol distributions, (3) to establish synoptic-scale descriptions of the magnitude and height variations of optical turbulence, (4) to relate near-surface aerosol distributions to white-cap coverage, (5) to determine dispersion properties of the atmospheric boundary layer in the California coastal region and (6) to evaluate synoptic-scale forcing on the boundary processes and evolutions utilizing data from single (in-situ) stations.

Long-range objectives of this work are to provide tactical assessment and predictive procedures for electromagentic, optical and dispersion properties of the marine boundary layer.

FORECASTING MARINE AIR/OCEAN PARAMETERS USING MODEL OUTPUT STATISTICS

A multiple-year project directed toward applying the methods of model output statistics (MOS) to forecasting operationally important air and ocean parameters to 48 hours, for all oceans of the world, continued in FY85. The research, involving R. J. Renard, is presently concerned with forecasting horizontal visibility near the surface, fog, and cloud height and ceiling, over the North Atlantic Ocean area. Predictor information is being derived from the Navy's Operational Global Atmospheric Prediction System (NOGAPS). Forecast strategies include three conditional probability approaches; linear regression with minimum probable error and maximum-liklihood-of-detection threshold models; and the principal discriminant method. In progress is an experiment using statistically designed simulated data sets, with controllable parameter distributions, for the purpose of testing the skill of the various forecast methodologies under specified conditons involving observer bias and predictor/predictand relations.

REGIONAL WEATHER GUIDES

F. R. Williams and R. J. Renard (with collaborative efforts from G. H. Jung, Oceanography Department, and others) completed the Forecaster's Handbook for the Southern African Continent and Atlantic/Indian Ocean Transit, distrubuted by the Naval Environmental Prediction Research Facility. The handbook includes sections on Southern Hemisphere climatology, and synoptic and meso-scale meteorology, as it affects air/sea operations over and near the Southern African Continent.

SATELLITE REMOTE SENSING

K. L. Davidson is involved in experimental verification on mechanisms responsible for synthetic aperature radar (SAR) images of the ocean surfaces. Measurements of surface stress are being made on a tower off the California Coast, near San Diego, in conjunction with aircraft and Space Shuttle (Shuttle Imaging Radar) overflights. P. A. Durkee is examining the relationship between satellite-detected visible and infrared radiance and extinction by aerosols. C. H. Wash and P. A. Durkee are applying interactive computer techniques to GOES and NOAA visual, infrared and other radiometric data to specify cloud and precipitation patterns using the NEPRF Satellite Processing and Aquisition System and the NPS VAX/COMTAL System. C. H. Wash is also using high resolution Space Shuttle photography to better understand mesoscale cloud structure in NASA and DMSP imagery.

Title:	Evaluation of NOGAPS Tropical and Medium Range Forecasts
Investigators:	J. S. Boyle, Adjunct Professor of Meteorology C. H. Wash, Associate Professor of Meterorology C.-P. Chang, Professor of Meteorology
Sponsor:	Naval Air Systems Command
Objective:	To evaluate the numerical weather prediction products of NOGAPS with special emphasis on the medium-range (3-5 day) and the tropical forecasts.

Summary:	Systematic errors of wind, heights and temperature have been computed for the winter of 1983/84, summer 1984 and winter 1984/85. The case study of Asian cold surges in NOGAPS 24 h forecast done last year has been extended to 72 h which shows that the underestimate of jet acceleration due to inadequate divergence representation becomes progressively worse. The summer data indicate that NOGAPS underestimates the monsoon circulation around the Indian Ocean and in southern Asia. The Somali jet and other circulation features are too weak in the model. Comparison with CAC OLR fields indicate that the model forecast convective precipitation fields become less realistic with time. These discrepancies in the convective fields partly explain the wind errors. The continents are too cold at low levels in the summer. In the winter the continents are too cold and the oceans are too warm. This creates spuriously strong sea level baroclinic zones off the east coast of continents. The winter Asian monsoon is also underestimated. The height fields over the Northern Hemisphere oceans reflect the fact that the model cyclones develop too slowly in the western oceans and deepen too much as they pass to the east.

Publications:	C.-P. Chang and K. G. Lum, "Tropical-Midlatitude Interaction over Asia and the Western Pacific during the 1983/84 Northern Winter", Monthly Weather Review, 113, 1345-1358. J. S. Boyle and C. H. Wash, "Evaluation of NOGAPS 2.1 Systematic Error - Winter 1983/84", NPS Tech. Rep. 63-85-002, 69 pp.
Thesis Directed:	J. Curtis, "An Investigation of High and Low Predictability Periods of NOGAPS 2.1 Medium Range Forecasts", Master's Thesis, December 1985.

Title:	Interactions of Synoptic and Interannual Variations of Large-Scale Motions during Winter
Investigator:	Chih-Pei Chang, Professor of Meteorology
Sponsor:	National Oceanic and Atmospheric Administration
Objective:	To study the interannual variations of the large-scale flow over the Asia-Pacific region and their interaction with the synoptic flow.

Summary: A nine year wind climatology has been prepared using the U.S. Navy's operational, twice daily wind analyses. These data are produced on a global band from 60°N to 40°S on a mercator grid of approximately 2.5 degrees resolution. The levels which are analyzed are the surface, 700, 400 and 200 mb. In addition to the basic wind data, fields of streamfunction and velocity potential have also been computed for all levels. For the 200 mb level fields of E-vectors (Hoskins, et al., 1983) are also calculated. Time series of the wintertime (15 November - 15 March) gridded data have been time filtered into low frequency (periods > 10 days), middle frequency (periods 2.5 to 6 days) and high frequency (periods < 2 days) components. Mean fields of these components have been generated and are used to demonstrate their interseasonal variations. Seasonal anomalies in the large-scale circulation are studied in relation to seasonal mean tropical forcing and extra-tropical transient eddy forcing, using both the tropical wind and outgoing longwave radiation (OLR) climatology. Results show that extreme swings in anomalous convection over the maritime continent of Indonesia/Borneo and the equatorial central Pacific respectively are linked by an east-west seesaw or dipole pattern, identified with major fluctuations of the Pacific Walker circulation. While the tropical response is found to be well described by linear dynamics, the extratropical response may be nonlinear with respect to the polarity of the dipole heating pattern.

Publications: C.-P. Chang and K. G. Lum, "Tropical-Midlatitude Interaction over Asia and the Western Pacific Ocean during the 1983/4 Northern Winter", Monthly Weather Review, 113, 1345-1358.

C.-P. Chang, "A Review of Midlatitude Tropical Interactions over East Asia during Cold Surges", Papers in Meteorological Research, 7, (forthcoming).

K. M. Lau and J. S. Boyle, "Tropical and Extratropical Forcing of the Large-Scale Circulation: A Diagnostic Study", Monthly Weather Review, (submitted).

Conference
Presentation: J. S. Boyle and C.-P. Chang, "Interseasonal Variations in
                 the Northern Winter Atmospheric Tropical/Subtropical
                 Circulation for the Period 1974 to 1983", IAMAP-IAPSO
                 Joint Symposium of Monsoon Circulation in Oceans and
                 Atmosphere, Honolulu, HI, 5-16 August 1985.

Thesis Directed: K. G. Lum, "The Influence of Large-Scale 200 mb Tropical
                 Divergence Events on the Midlatitude Zonal Flow over the
                 Asia-Pacific Region during the 1983-84 Winter", Master's
                 Thesis, June 1985.

Title:	Tropical and Monsoon Studies
Investigators:	Chih-Pei Chang, Professor of Meteorology and R. T. Williams, Professor of Meteorology
Sponsor:	National Science Foundation
Objective:	To study the structure and dynamics of large-scale flow in the tropics and other areas which are influenced by monsoons. This is a continuing project.

Summary: A ten-year data set from 1975-1984 is used to study the Mei-Yu front over China during the East Asian summer monsoon. From early June to mid-July, a localized, subsynoptic scale anticyclone develops on the eastern part of the Tibetan plateau. A cold front frequently develops to the northwest of this anticyclone and extends from Northeastern China towards the heat low region over India. As the front approaches the subsynoptic scale anticyclone, its western segment may either become stationary and appear to be blocked by the Tibetan plateau, or may appear to jump abruptly southward over the plateau to become the quasi-stationary Mei-Yu front in southern China. In this investigation the upper-level large-scale flow associated with the front is studied and the frontogenesis and frontolysis at the two stationary locations are computed to elucidate the mechanism of the development and behavior of the Mei-Yu system. On winter monsoon studies, a numerical simulation of cold surge initiation with a global baroclinic model was carried out. The results showed the important role of planetary waves in the process. Other works include the study of barotropic instability zonally varying flow, and possible interactions between the northern winter and the southern summer monsoons.

Publications: C.-P. Chang, "A Review of Midlatitude Tropical Interactions over East Asia during Cold Surges", Papers in Meteorological Research, 7, (forthcoming).

C.-P. Chang, "Midlatitude-Tropical Interactions During Winter", Proceedings of the First National Workshop on the Global Weather Experiment: Current Achievements and Future Directions. Volume II, 543-559.

C.-P. Chang and K. G. Lum, "Tropical-Midlatitude Interaction over Asia and the Western Pacific Ocean during the 1983/84 Northern Winter", Monthly Weather Review, 113, 1345-1358.

H. Lim and C. P. Chang, "Generation of Internal- and External Mode Motions from Internal Heating: Effects of Vertical Shear and Damping", Journal of Atmospheric Sciences, (in revision).

M. S. Peng and R. T. Williams, "Spatial Instability of the Barotropic Jet with Slow Streamwise Variation", Journal of Atmospheric Sciences, (submitted).

M. S. Peng and R. T. Williams, "A Note on the Relation between Temporal and Spatial Growth Rates", Journal of Atmospheric Sciences, (submitted).

Conference Presentation:	C.-P. Chang, K. M. Lau and H. Lim, "Midlatitude-Tropical Interaction Associated with the Winter Monsoon", Report of the FGGE Seminar on Progress in Tropical Meteorology, GARP Special Report No. 44, World Meteorological Organization, Tallahassee, FL, October 1984, p.VI37-52.

C.-P. Chang, "Planetary Scale Rossby Wave Response to Tropical Heat Sources" (Invited Review), Commemorization of the 60th Anniversary of the Chinese Meteorological Society, Nanjing, People's Republic of China, 10-15 October 1984.

C.-P. Chang and M. S. Peng, "Variations of Mei-Yu Fronts over China", Second U.S.-P.R.C. Cooperative Workshop on Monsoon Research, Monterey, CA, 10-13 June 1985.

M. S. Peng and C.-P. Chang, "On the Mei-Yu Front of the East Asian Summer Monsoon", IAMAP-IAPSO Joint Symposium on Monsoon Circulation in Oceans and Atmosphere, Honolulu, HI, 5-16 August 1985.

J. S. Boyle and C.-P. Chang, "Interseasonal Variations in the Northern Winter Atmospheric Tropical/Subtropical Circulation for the Period 1974 to 1983", IAMAP-IAPSO Joint Symposium on Monsoon Circulation in Oceans and Atmosphere, Honolulu, HI, 5-16 August 1985.

Theses Directed:

K. A. Shield, "Possible Cross Equatorial Influence of the Northeast Monsoon on the Equatorial Westerlies over Indonesia", Master's Theis, March 1985.

K. G. Lum, "The Influence of Large-Scale 200 mb Tropical Divergence Events on the Midlatitude Zonal Flow over the Asia-Pacific Region during the 1983-84 Winter, Master's Thesis, June 1985.

N. E. Harris, "Numerical Simulation of Cold Surges", Master's Thesis, September 1985.

Title: Satellite Remote Sensing of Marine Atmospheric
                    Boundary Layer (MABL) Chaaracteristics

Investigator: P. A. Durkee

Sponsor: NPS Foundation Research Program

Objective: This was the first of a multi-year effort to investigate
                    remote sensing techniques applicable to the marine
                    atmospheric boundary layer.

Summary: This year's effort was devoted to implementing software
                    for data analysis and radiative transfer routines. The
                    investigataion emphasized the effects of particles above
                    the MABL, variable wind speed, and MABL depth. A
                    technique to detect particles above the MABL was
                    developed and tested. This technique uses dual-wave-
                    length, satellite-detected, radiance measurements to
                    estimate variations in the slope of the aerosol particle
                    size distribution. Distributions of varying slope,
                    in turn imply variations of particle type and origin.

Publications: P. A. Durkee, D. R. Jensen, E. E. Hindman and T. H.
                    Vonder Haar, "The Relationship Between Marine Aerosol
                    Particles and Satellite-Detected Radiance", Journal of
                    Geophysical Research, forthcoming.

                    P. A. Durkee, "Aerosol Characteristics Inferred from
                    Dual-Wavelength Radiance Measurements", Journal of
                    Geophysical Research, in progress.

Conference
Presentation: P. A. Durkee, "The Vertical Distribution of Marine
                    Aerosols Inferred from Dual-Wavelength Radiance Measure-
                    ments", Topical Meeting on Optical Remote Sensing of
                    the Atmosphere, Optical Society of America, Incline
                    Village, NV, 15-18 January 1985.

                    P. A. Durkee, E. E. Hindman and T. H. Vonder Haar,
                    "Marine Boundary Layer Characterization from Satellite-
                    Detected Aerosol Optical Depth", IAMAP/IAPSO Joint
                    Assembly, Honolulu, HI, 5-16 August 1985.

Title: Air-Sea Interaction Studies

Investigator: R. L. Elsberry, Professor of Meteorology

Sponsor: Naval Air Systems Command (AIR - 370F)

Objective: To improve medium-range atmospheric forecasts through
                    coupled atmosphere-ocean model studies.

Summary: Naval Operational Global Atmospheric Prediction System
                    model forecasts to 10 days with a fixed sea-surface
                    temperature field are compared with hindcasts
                    in which the observed sea-surface temperatures each 12
                    hours are imposed. The first case study from Spring 1983
                    has been completed (Ranelli, et al., 1985). Two
                    additional cases during Fall 1983 and Spring 1984 have
                    been studied (Rovero, et al., 1985). Although local
                    differences in surface heat fluxes may be quite large,
                    the net effect on positions and intensities of extra-
                    tropical cyclones is comparatively smaller than the
                    overall errors of the control and time-dependent
                    integrations.

Publication: P. H. Ranelli, R. L. Elsberry, Chi-Sann Liou, and S. A.
                    Sandgathe, "Effects of Varying Sea-Surface Temperature
                    on 10-Day Atmospheric Model Forecasts". Chapter 39,
                    Coupled Ocean-Atmosphere Models, Elsevier Science
                    Publishers (Amsterdam), 675-695, 1985.

Conference
Presentation: P. J. Rovero, C.-S. Liou, and R. L. Elsberry, "Effects of
                    Time-dependent Sea-surface Temperatures on Atmospheric
                    Model Predictions to 10 Days". Seventh Conference on
                    Numerical Weather Prediction, Montreal, Canada, June
                    1985, pp. 362-368.

Title: Observational-Numerical Study of Maritime Extratropical
                    Cyclones Using FGGE Data

Investigators: R. L. Elsberry, Professor of Meteorology
                    C. H. Wash, Associate Professor of Meteorology

Sponsor: National Aeronautical and Space Administration

Objective: To better understand the development, maturation and
                    decay of maritime extratropical cyclones using a combined
                    observational and numerical modeling approach.

Summary: Diagnostic studies of observed and numerically simulated
                    cases of maritime extratropical cyclones have been made
                    (Elsberry, et al., 1985). Quasi-Lagrangian diagnostic
                    budgets of mass, vorticity, angular momentum and heat
                    have been computed in pressure coordinates for observed
                    and model-generated cyclones (Peak, et al., 1985; Liou
                    and Elsberry, 1985; Sinclair, 1985). Numerical
                    simulations of the conditions that lead to Pacific polar
                    lows have demonstrated the importance of baroclinity and
                    latent heat release (Hodur, 1985).

Publications: R. L. Elsberry, C. H. Wash, C.-S. Liou, and J. E. Peak,
                    "Observational-numerical Study of Maritime Extratropical
                    Cyclones using FGGE Data". NPS Technical Report NPS-
                    63-85-001, 40 pp., 1985.

Conference
Presentations: C.-S. Liou, and R. L. Elsberry, "Physical Processes in
                    Prediction of Explosive Maritime Cyclogeneses",
                    Proceedings of the Seventh Conference on Numerical
                    Weather Prediction, Montreal, Canada, pp. 212-218,
                    June 1985.

                    J. E. Peak, C. H. Wash, K. A. Ebersole, and R. L.
                    Elsberry, " A Study of GLAS and UCLA Model Forecasts of
                    Explosive Maritime Cyclogenesis". Proceedings of Seventh
                    Conference on Numerical Weather Prediction, Montreal
                    Canada, pp. 528-535, 1985.

Theses Directed: R. M. Hodur, "A Numerical Study of the Pacific Polar
                    Low", Ph.D. Dissertation, December 1984.

                    M. A. Sinclair, "A Diagnostic Study of Baroclinic
                    Disturbances in a Polar Air System", Ph.D. Dissertation,
                    September 1985.

Title: Oceanic Current System Response to Atmospheric Forcing

Investigator: R. L. Elsberry, Professor of Meteorology

Sponsor: Office of Naval Research (Code 422PO)

Objective: To simulate the effect of strong atmospheric cooling evednts on the location and intensity of an oceanic current system such as the Gulf Stream.

Summary: Sensitivity studies of ocean thermal structure predictions to various averaging periods of the atmospheric forcing have been published (Adamec and Elsberry, 1984a). The dissertation research of Adamec (1985) addressed the oceanic response in strong current regions to cold outbreaks. The effect of a cross-stream gradient in cooling has been simulated in a two-dimensional model of the Gulf Stream (Adamec and Elsberry, 1984b; 1985a). Different latitudinal deflections are simulated if convective exchange of momentum is included or excluded. A moderate increase in the eastward wind stress has a greater effect on the position of the simulated Gulf Stream than does a very strong gradient in cooling. In the three-dimensional simulations (Adamec and Elsberry, 1985b; 1985c), the surface cooling increases in the downstream direction. Most of the flow changes near the Gulf Stream are induced by the cross-stream cooling gradient. In regions away from the front, where the vertical shear is not large, the responses in the flow fields are due solely to the along-stream cooling gradient. Because of the importance of momentum mixing parameterization in these simulations and those of oceanic response to hurricanes, this physical process needs to be explored in simulations and field experiments (Elsberry and Adamec, 1985).

Publications: D. Adamec and R. L. Elsberry, "The Effect of Mean Atmospheric Forcing in an Ocean Mixed-Layer Model." Journal of Physical Oceanography, 14, 1670-1676, 1984a.

D. Adamec and R. L. Elsberry, "Response of an Intense Oceanic Current System to Cross-Stream Cooling Events." Journal of Physical Oceanography, 15, 273-287, 1985a.

D. Adamec and R. L. Elsberry, "The Response of Intense Oceanic Current Systems Entering Regions of Strong Cooling." Journal of Physical Oceanography, 15, 1284-1295, 1985b.

Conference
Presentations: D. Adamec and R. L. Elsberry, "Response of an Intense Oceanic Current System to Cross-stream Cooling Events". American Geophysical Union Fall Meeting, San Francisco, CA, December 1984b.

D. Adamec and R. L. Elsberry, "Modifications of an
Intense Oceanic Current System Flowing into a Region of
Intense Cooling." IAMAP/IAPSO Joint Assembly, Honolulu,
HI, August 1985c.

R. L. Elsberry and D. Adamec, "Role of Momentum Mixing in
Upper Ocean Circulations". IAMAP/IAPSO Joint Assembly,
Honolulu, HI, August 1985d.

Thesis Directed: D. Adamec, "Numerical Simulations of the Response of
Intense Ocean Currents to Atmospheric Forcing." Ph.D.,
March 1985.

Title: Oceanic Response to Atmospheric Forcing

Investigator: R. L. Elsberry, Professor of Meteorology

Sponsor: Office of Naval Research (Code 422PO)

Objective: To understand and predict the response of the upper ocean
                 to atmospheric forcing.

Summary: The primary thrust in the research has been in ocean
                 response to hurricane forcing (Shay and Elsberry, 1985).
                 Three drifting buoys with 200 m thermistor chains were
                 successfully deployed in advance of Hurricane Josephine
                 (Black, et al., 1985a; 1985b). The trajectories suggest
                 that the buoys were incorporated into eddies in the
                 oceanic subtropical front, which will make extraction of
                 the hurricane-induced signal more difficult. Adamec and
                 Elsberry (1984) demonstrate the effect of using averaged
                 atmospheric forcing for ocean prediction.

Publications: D. Adamec and R. L. Elsberry, "The Effect of Mean
                 Atmospheric Forcing in an Ocean Mixed-Layer Model."
                 Journal of Physical Oceanography, 14, 1670-1676, 1984.

                 P. G. Black, R. L. Elsberry, L. K. Shay, and R. M.
                 Partridge, "Hurricane Josephine Surface Winds and Ocean
                 Response Determined from Air-deployed Drifting Buoys and
                 Concurrent Research Aircraft Data." Preprint 16th Tech.
                 Conf. on Hurricane and Trop. Meteor., Amer. Meteor. Soc.,
                 (Boston), 22-24, 1985a.

                 _____, "Preliminary Report of a Hurricane-ocean Field
                 Experiment in Hurricane Josephine". (In progress).

                 Shay, L. K. and R. L. Elsberry, "Near-inertial Ocean
                 Current Response to Hurricane Frederic." (In progress).

Title: Tropical Cyclone Prediction

Investigator: R. L. Elsberry, Professor of Meteorology

Sponsor: Naval Environmental Prediction Research Facility

Objective: To improve tropical cyclone prediction by incorporaating
                   storm-related factors and synoptic-environmental effects
                   in a decision tree approach.

Summary: Storm-related factors such as intensity, intensity
                   change, size of storm, initial latitude and longitude
                   have been categorized into terciles for all NTCM and
                   CLIPER forecasts of western North Pacific tropical
                   cyclones during 1981-83. Mean and median forecasts
                   errors, systematic latitudinal and longitudinal errors,
                   and cross-track and along-track errors have been
                   calculated for each tercile (Williams, 1985). An EOF
                   representation of the wind fields at three levels around
                   the tropical cyclone has been used as predictors of the
                   future track. An independent sample of 600 cases has
                   been used to demonstrate that the EOF statistical
                   regression approach results in good 48 and 72 h
                   forecasts (Elsberry, Wilson, Peak and Chan, 1985;
                   Wilson, 1984). An objective scheme for estimating the
                   warning position of the tropical cyclone from the fixes
                   received during the past 6 h has been developed.
                   Weighting factors for different observational platforms
                   and for the time of the fix have been incorporated. The
                   objective positions are generally superior to the JTWC
                   operational positions during 1981 and 1982 and are
                   nearly as good as the JTWC during 1983 (Curry, 1985;
                   Curry, Elsberry and Chan, 1985). Cross-track and along-
                   track errors of the official and objective aids used at
                   JTWC have been summarized for 1979-83 (Elsberry and
                   Peak, 1986). The One-way Tropical Cyclone Model and the
                   Nested Tropical Cyclone Model generally produce the most
                   accurate forecasts at 72 h. It is also demonstrated
                   that a stratification of situations by the recent motion
                   of the storm produces useful information about which
                   objective aid is most effective. An EOF representation
                   of the geopotential field and other persistence-related
                   predictors have been used to make predictions of turning
                   motion and acceleration of tropical cyclones (Peak and
                   Elsberry, 1986). The performance of the scheme is
                   improved if separate regression equations are derived
                   for five categories of past motion. Data have been
                   analyzed to determine the causes of the anomalous track
                   guidance received during Typhoon Abby (1983). The
                   intensity and enormous circulation (radius of 30 kt
                   winds over 600 km) of the supertyphoon are apparently
                   the reasons for the failure of the objective aids. Abby
                   was moving almost normal to the steeering flow.
                   Consideration of these factors may prevent similar

incidents in the future (Chan, 1985).

Publications: J. C.-L. Chan, "Supertyphoon Abby - An Example of
Present Track Forecast Inadequacies". (In progress)

J. C.-L. Chan, B. J. Williams, and R. L. Elsberry,
"Performance of the Nested Tropical Cyclone Model for
Different Storm-related Parameters". (In progress)

R. L. Elsberry, and M. Fiorino, "Design Considerations
for an Advanced Tropical Cyclone Model". NAVENVPREDFAC
Tech. Rep. 85-03, 152 pp., 1985.

R. L. Elsberry, and J. E. Peak, "An Evaluation of
Tropical Cyclone Forecast Aids based on Cross-track and
Along-track Components". Monthly Weather Review (forth-
coming), 1986.

J. E. Peak, and R. L. Elsberry, "Prediction of Tropical
Cyclone Turning and Acceleration using Empirical
Orthogonal Function Representations". Monthly Weather
Review (forthcoming), 1986.

Conference
Presentations: W. T. Curry, R. L. Elsberry, and J. C.-L. Chan, "AN
Objective Determination of Tropical Cyclone Warning
Positions". 16th Conference on Hurricanes and Tropical
Meteorology, Proceedings, 92-94, 1985.

R. L. Elsberry, "Results of a Short Curse on the
Advanced Tropical Cyclone Model (ATCM)". Proceedings,
U. S. Pacific Command Tropical Cyclone Conference, 204-
217, 1985.

D. E. Hinsman, R. L. Elsberry, and J. Hovermale,
"Development of the Navy Advanced Tropical Cyclone Model
(ATCM)". Presented at 16th Conference on Hurricanes and
Tropical Meteorology, 1985.

J. E. Peak, and R. L. Elsberry, "Objective selection of
Optimum Tropical Cyclone Guidance using a Decision-tree
Methodology". Proceedings, 16th Conference on
Hurricanes and Tropical Meteorology, 97-98, 1985b.

W. E. Wilson, R. L. Elsberry, J. E. Peak, and J. C.-L.
Chan, "Prediction of Tropical Cyclone Motion based on
an EOF Representation of the Environmental Wind Fields".
Proceedings 16th Conference on Hurricanes and Tropical
Meteorology, 180-181, 1985.

Theses Directed: Curry, W. T., "An objective determination of tropical
cyclone waring positions", Masters Thesis, 58 pp., June
1985.

Williams, B. J., "Effects of storm-related parameters on the accuracy of the Nested Tropical Cyclone Model", Masters Thesis, (in progress).

Wilson, W. E., "Forecasting of tropical cyclone motion using an EOF representatiion of wind forcing". Masters Thesis, 88 pp., December 1984.

Title:	Eddy Generation Mechanisms in Eastern Boundary Current Regions
Investigator:	Robert L. Haney, Professor of Meteorology
Sponsor:	Office of Naval Research

Objective: This project is to investigate processes responsible for the generation, evolution and decay of intense synoptic scale variability observed in eastern boundary current regimes, with particular application to the California Current region. It's ultimate goal is to enhance our understanding of eddy generating processes in such regimes, and to thereby provide a basis for high resolution numerical analysis and prediction in these ocean regions.

Summary: A 15-level primitive equation ocean model with surface layer physics has been adapted to include an idealized Mendocino escarptment and continental slope along a straight meridional coastline. The model is in sigma coordinates (non-dimensional depth) and has open boundaries (radiation condition) on all but the eastern coastal boundary. We are presently studyding the response of idealized flows over the escarpment for which there are analytic solutions. Model sensitivity studies will be made to determine the dependence of the solutions on the parameterization of sub-grid scale processes and on the choice of boundary conditions on the flow at the bottom, on the slope and at the eastern boundary. We expect to study the eddy generation process in response to seasonal and "event" type wind relaxations as well as a number of different mean flow regimes which have been observed upstream of the Mendocino escarpment. The ultimate goal is to understand and predict the generation of synoptic scale eddies which are being observed south of Cape Mendocino by the OPTOMA program.

Publications: R. L. Haney, "Midlatitude Sea-Surface Temperature Anomalies: A Numerical Hindcast", J. Phys. Oceanogr., 15, (6), (June 1985), 787-799.

R. L. Haney, "Some SST Anomalies I Have Known, Thanks to Jerome Namias", submitted for publication in Namias Commemorative Volume, September 1985 (20 pp).

Conference
Presentation: R. L. Haney, "SST Anomalies in the Midlatitude North Pacific Ocean: A Model Hindcast", IAMAP/IAPSO Joint Assembly, August 5-16, 1985, Honolulu, HI.

M. L. Batteen, R. L. Haney and C. N. K. Mooers, "Coastal and bathymetric influences on eddy generation in the California Current System", IAMAP/IAPSO Joint Assembly, August 5-16, 1985, Honolulu, HI.

Title: Model Output Statistics for Forecasting Air/Ocean
                Parameters Important to the U. S. Navy

Investigators: R. J. Renard, Professor of Meteorology
                R. A. Hale, Meteorologist, Department of Meteorology
                R. W. Preisendorfer, Scientist, NOAA, Pacific Marine
                Environmental Laboratory, Seattle, WA.

Sponsor: Naval Air Systems Command

Objective: Using selected mehtods of model output statistics,
                develop prediction schemes to forecast (out to 48 hr)
                air/ocean parameters of operational importance to U.S.
                Navy activities over the open ocean and coastal waters.

Summary: A multiple-year project directed toward applying the
                methods of model output statistics (MOS) to forecasting
                operationally important air and ocean parameters to 48-h,
                for all the oceans of the world, continued in FY 1985.
                The research is initially concerned with forecasting
                horizontal visibility near the surface, and cloud amount
                and ceiling over the North Atlantic Ocean area. The area
                has been stratified into physically homogeneous sections
                to maximize forecasting skill. Predictor information is
                being derived using a basic set of 56 output parameters
                from the Fleet Numerical Oceanography Center's Navy
                Operational Global Atmospheric Prediction System
                (NOGAPS). Prediction strategies include three
                conditional probability approaches (two maximum
                probability schemes and natural regression); linear
                regression with minimum probable error (i.e., equal
                variance and quadratic) and maximum-liklihood-of-
                detection threshold models; and the principal
                discriminant method. Potential predictability and
                functional dependency of predictors are computed along
                with verification statistics based on class error and
                threat scores. In progress is an experiment using
                statistically designed simulated data sets, with
                controllable parameter distributions, for the purpose of
                testing the skill of the various forecast methodologies
                under specified conditions involving observer bias and
                predictor/predictand relations.

Publications: R. W. Preisendorfer, "The principal discrimimant method
                of prediction", unpublished manuscript, Naval Postgrad-
                uate School, Monterey, CA, 15 pp.

                R. W. Preisendorfer, "Notes on the design of simulation
                data sets for MOS (Model Output Statistics) prediction
                methods", unpublished manuscript, Naval Postgraduate
                School, Monterey, CA, 42 pp.

Theses Directed: M. Diunizio, "An evaluation of statistical significance associated with the results of my September 1984 thesis based upon the null hypothesis and associated 95% confidence intervals", unpublished manuscript, Department of Meteorology, Naval Postgraduate School, Monterey, CA, 1984, 22 pp.

K. C. Elias, "Forecasting atmospheric visibility over the summer North Atlantic using the principal discriminant method. Master's Thesis (R. J. Renard and R. W. Preisendorfer, advisors), Department of Meteorology, Naval Postgraduate School, Monterey, CA, 1985, 112 pp.

M. H. Wooster, "An evaluation of discretized conditional probability and linear regression threshold techniques in model output statistics forecasting of cloud amount and ceilings over the North Atlantic Ocean", Master's Thesis (R. J. Renard, advisor), Naval Postgraduate School, Monterey, CA, 1985, 187 pp.

Title: Regional Synoptic Forecasting: Southern African
                    Continent and Surrounding Ocean Areas

Investigators: R. J. Renard, Professor of Meteorology
                    F. R. Williams, Adjunct Professor of Meteorology

Spcnsor: Naval Air Systems Command

Objective: To assess the status of and make improvements on the
                    analysis and forecastinfg of weather parameters important
                    to air/sea operations over the Southern African Continent
                    and surrounding South Atlantic/Indian Ocean areas
                    (approximately 5°N-45°S, 60°E-0°).

Summary: The Forecaster's Handbook for the Southern African
                    Continent and Atlantic/Indian Ocean Transit has been
                    completed, with publication expected in November 1985.
                    The handbook describes the analysis and forecasting of
                    atmospheric and oceanic conditions important to air/sea
                    operations over and near the southern African Continent,
                    to include Kenya, Tanzania, Mozambique, Republic of South
                    Africa and Namibia. Weather over the Malagasy Republic
                    (formerly Madagascar), Mauritius and Reunion (the
                    Mascarene Islands), and Seychelles Islands is also
                    addressed).

                    Included are descriptions of such coastal phenomena as
                    fog, gales and onshore/offshore winds, as well as an in-
                    depth review of the Agulhas and Benguela near-shore
                    oceanic currents. Southern Hemisphere climatological
                    data are given for seasonal tracks of cyclones and
                    anticyclones, atmospheric frontal positions, wave
                    heights, sea-surface temperatures and other parameters.

                    Case studies describe tracks and speeds of extratropical
                    cyclones affecting the South Atlantic and western Indian
                    Oceans during the Southern Hemisphere winter, and the
                    anomalously high seas ("Cape Rollers") found near the 100
                    fathom contour when high ocean waves, driven by strong
                    southwesterly winds, oppose the Agulhas Current near the
                    southeastern coast of the Republic of South Africa.

Publications: Williams, F. R., R. J. Renard, G. H. Jung, R. D. Tomkins,
                    R. R. Picard, "Forecaster's Handbook for the Southern
                    African Continent and Atlantic/Indian Ocean Transit",
                    Naval Environmental Prediction Research Facility, 1985
                    TR 84-08, 325 pp.

Title: Air Flow over Large Scale Topography

Investigators: M. A. Rennick, Adjunct Professor of Meteorology
                    R. T. Williams, Professor of Meteorology
                    M. S. Peng, Adjunct Professor of Meteorology

Sponsor: National Science Foundation

Objective: To utilize observational results from ALPEX with
                    theoretical and numerical studies to investigate the
                    interaction between air flow and large scale
                    topography.

Summary: The formation of cyclones in the lee of a long
                    mountain range was studied with analytic and numerical
                    models and the principal mechanism was isolated. The
                    interaction of deformation forced fronts with
                    topography was investigated. The two scale method was
                    applied to baroclinic instability in a zonally varying
                    basic current, which could have been forced by
                    topography.

Conference
Presentation: Peng, M. S. and R. T. Williams, Spatial Instability of
                    Nonparallel flows in the Two-layer Baroclinic Model.
                    Fifth Conference on Atmospheric and Oceanic Waves and
                    Stability of the American Meteorological Society,
                    New Orleans, LA, March 4-7 1985.

Theses Directed: J. L. Hayes, "A Numerical and Analytical Investigation
                    of Lee Cyclogenesis:, Ph.D. Dissertation, March 1985.

                    D. A. Zonkofski, "Interactions of Fronts with
                    Topography", Masters Thesis, June 1985.

Title:	**Large-Scale Atmosphere-Ocean** Coupling
Investigators:	Mary Alice Rennick, Adjunct Professor of Meteorology Robert L. Haney, Professor of Meteorology
Sponsor:	National Science Foundation
Objective:	To investigate and identify processes responsible for large scale air-sea interaction in the equatorial region associated with the El Nino-Southern Oscillation (ENSO) phenomenon.

Summary: An analytic investigation of unstable air-sea interactions in a coupled reduced-gravity ocean-atmosphere model of the equatorial region has been completed. The results demonstrate the extreme sensitivity of the coupled air-ocean system to processes that effect the ocean surface temperature. Numerical calculations using the nonlinear version of our model substantiate the basic conclusions of the analytic study, and provide further insight into processes that effect the sea surface temperature during the early phase of an ENSO event. Finally a comment was made on a previous model study by Anderson and McCreary (J. Atmos. Sci., 1985) which was based on an improper formulation of upper ocean physics.

Publications: M. A. Rennick, and R. L. Haney, "Stable and Unstable Air-Sea Interaction in the Equatorial Region", (26 pp) submitted to J. Atmos. Sci. (July 1985).

R. L. Haney, and M. A. Rennick, "Comments on 'Slowly Propagating Disturbances in a Coupled Ocean-Atmsophere Model'", J. Atmos. Sci., (1985 (3 pp.) in press).

Conference
Presentation: R. L. Haney and M. A. Rennick, "Air-Sea Interaction in Coupled Shallow Water Models of the Equatorial Atmosphere and Ocean", AGU Fall Annual Meeting, December 3-7, 1984, San Francisco, CA.

M. A. Rennick and R. L. Haney, "A model of oceanic response to anomalous wind forcing in the equatorial Pacific", IAMAP/IAPSO Joint Assembly, August 6-16, 1985, Honolulu, HI.

Title: Atmospheric Profiles of Optical Turbulence

Investigators: W. J. Shaw and D. L. Walters (Principal Investigators) and K. L. Davidson and P. J. Boyle (Associate Investigators).

Sponsor: Naval Environmental Prediction and Research Facility

Objective: To interpret data on vertical profiles of the refractive index structure parameter C_T^2 and to compare it with recent models which are based on measured mean properties of the troposphere and stratosphere.

Summary: Work of this project has just begun. Tasks which are being pursued include: (1) Matching parameters of the Wyngaard-Letlone model for C_T^2 in the inversion to measured radiosonde information from the Mixed Layer Deepening Experiment (MILDEX) (2) Obtaining interfacial and transitional layer values of C_T^2 from simultaneous sodar measurements and (3) comparing modeled and observed values of C_T^2.

Title: **Investigation of Atmospheric Boundary Layer Processes in
                    the Santa Barbara Channel**

Investigators: W. J. Shaw (Principal), C. E. Skupniewicz (Associate)

Sponsor: Western Oil and Gas Association

Objective: To obtain atmospheric boundary layer (ABL) measurements
                   which will be useful in studying diffusion and mesoscale
                   circulations of the Santa Barbara Channel and to advance
                   the system development effort of NPS's Environmental
                   Physics Group. The latter includes verification of the
                   recent calibration of our sodar system and the
                   development of a shipboard bivane system integrated with
                   a three-axis gyro to remove ship motion from wind
                   measurements.

Summary: We participated during September in the South Central
                   Coast Cooperative Aerometric Monitoring Project (SCCCAMP)
                   using instrumentation aboard the R/V Acania and using a
                   shore station which included the NPS sodar. The Acania
                   made surface meteorological and radiosonde measurements
                   at a variety of locations in the Santa Barbara Channel
                   for the 24 days of her participation in the project. In
                   addition, sodar and tower meteorological measurements
                   were made almost continuously from early September
                   through mid-October. Analysis of these data is just
                   underway.

Title: Investigation of the Structure and Evolution of the Coastal ABL using an Acoustic Doppler Sodar System

Investigator: W. J. Shaw

Sponsor: NPS Foundation Research Program

Objective: The objective of this work was to initiate surface-based remote sensing and high-resolution radiosonde data acquisition capabilities for the atmospheric boundary layer which will ultimately yield insight into: the relationship between inversion wind shear and ABL small-scale structure and entrainment energetics; ABL structure resulting from inhomogeneities of the coastal region; and the relationship between the structure of the coastal ABL and larger-scale weather systems.

Summary: The primary task in this effort was the calibration of the NPS sodar for the measurement of the acoustic refractive index structure parameter, C_T^2. This was accomplished by two methods: (1) an in situ technique (described in deRouge's thesis) in which $\overline{C_T^2}$ was generated from similarity theory of atmospheric surface layer turbulence and compared directly with system output and (2) NPS anechoic chamber measurements of the sodar antenna's near-field acoustic phase and amplitude distrubution for a given imput voltage. This two-dimensional distribution is then Fourier-transformed to obtain the antenna far-field gain pattern. Transducer efficiencies for acoustic/electrical conversion were measured using a calibrated microphone. This information provides the second calibration. Additional substantial effort was given to the revision of software for the Beukers W8000RP radiosonde system obtained through this funding. The system now works properly and reliably. Together the sodar and radiosonde systems now provide excellent quantitative measurements of the mean and turbulent structure of the ABL.

Thesis Directed: E. deRouge, "An Investigation of the Atmospheric Boundary Layer over the Arctic Ocean using Sodar". Master's Thesis, September 1985.

Title: GOES Satellite Data Analysis for Weather Analysis and
                    Forecasting

Investigator: C. H. Wash, Associate Professor of Meteorology

Sponsor: Naval Air Systems Command

Objective: Implement algorithms to analyze GOES visual, infrared
                    and other channel data to produce specification of
                    hazardous surface weather for naval operations
                    (presence of precipitation intensity, low visibilities
                    and ceilings) in silent areas between conventional
                    observations using the SPADS system.

Summary: Satellite cloud and precipitation estimation program
                    evaluation was modified for winter, spring and fall
                    seasons. Collected GOES and surface data sets are
                    being used to further develop cloud mapping techniques.

Publications: Wash, C., L. Spray and L. Chou, "Satellite Cloud and
                    Precipitation Analysis Using a Minicomputer". Naval
                    Environmental Prediction Research Facility, NPS 63-85-
                    003, November 1985, 90 pp.

Title: Development of Finite Element Prediction Model

Investigators: R. T. Williams, Professor of Meteorology
                      A. L. Schoenstadt, Professor of Mathematics
                      R. E. Newton, Professor of Mechanical Engineering
                      M. S. Peng, Adjunct Professor of Meteorology

Sponsor: Naval Air Systems Command

Objective: To develop and test a finite element atmospheric
                      prediction model.

Summary: The Canadian finite element program was modified to
                      include time dependent boundary conditions. Three
                      vertical finite elements schemes were developed
                      [Jordan (1985)] and compared with the correspondidng
                      finite difference schemes. An analytic study of the
                      finite element advection equation was carried out by
                      Neta and Williams (1985) with four types of triangular
                      elements and the usual rectangular elements. Also
                      Neta, Hinsman and Williams (1985) studied a finite
                      element model with topography.

Publications: Neta, B., and R. T. Williams, "Stability and Phase
                      Speed for Various Finite Element Formulations of the
                      Advection Equation". Submitted to Computers and
                      Fluids (1985).

Conference
Presentation: Neta, B., D. Hinsman and R. T. Williams, Studies in a
                      Shallow Water Fluid Model with Topography. Eleventh
                      IMAC World Congress, Oslo, Norway, 5-9 August 1985.

Thesis Directed: M. S. Jordan, "A Comparison of Six Vertical
                      Discretization Schemes", Masters Thesis, September
                      1985.

Title:	Numerical Modeling of Unique Atmopspheric Phenomena
Investigators:	R. T. Williams, Professor of Meteorology M. A. Rennick, Adjunct Professor of Meteorology
Sponsor:	Naval Air Systems Command
Objective:	Develop and test better numerical techniques for use in Navy weather forecasting models.

Summary: The UCLA potential enstrophy model was compared with the NEPRF spectral model with integrations up to ten days. Two grid sizes were used with the finite difference model and three truncations were used with the spectral model. The behavior of planetary waves as a function of heating and initial conditions was studied with the NEPRF spectral model [McAtee (1984)]. It was concluded that the barotropic planetary waves are insensitive to reasonable heating profiles. A numerical study of lee-cyclogenesis was completed [Hayes (1985)]. An analytic study of introduction of mountains through slow growth was carried out.

Theses Directed: J. L. Hayes, "A Numerical and Analytical Investigation of Lee Cyclogenesis", Ph.D. Dissertation, March 1985.

M. D. McAtee, "Sensitivity of Planetary Waves to Initial Conditions and Forcing", Masters Thesis, December 1984.

DEFENSE

RESOURCES MANAGEMENT

EDUCATION CENTER

DEFENSE RESOURCES MANAGEMENT EDUCATION CENTER

In support of our mission to provide defense resource management education to the DoD, the program of faculty research at the Defense Resources Management Education Center (DRMEC) includes:

1. Military manpower issues of supply, demand, selection and training.

2. Organizational commitment.

3. Artificial Intelligence, Expert Systems, Decision Support Systems and the use of microcomputers in decision making.

4. Terrorism.

5. Public budgeting and public expenditure decision making behavior.

6. Economic effects of defense expenditures.

7. Energy economics.

8. International capital markets and investment models.

9. Time series modeling.

10. Effectiveness/evaluation methodology.

11. Conflict management/global simulation modeling.

For a list of academic publications by the faculty, please contact the Executive Director, DRMEC, Code 64, Naval Postgraduate School.

Title:	Contractor Engineering and Technical Services
Investigator:	R. E. Boynton, Associate Professor of Management
Sponsor:	Chief of Naval Operations
Objective:	To conduct a preliminary study of the Factors contributing to the high level of reliance on Contractor Engineering and Technical Services in Navy aircraft maintenance.

Summary:	This field study relates the use of engineering and technical services specialists (ETS) to interview and questionnaire responses gathered from Navy and Marine air maintenance organizations in the Pacific Area. The major findings indicate that both contractor (CETS) and in-house (NETS) specialists are needed to provide special training and assistance to compensate for low levels of formal training, personnel shortages, erosion of the technical experience base, and the increasing technological levels of aircraft and equipment. Recommendations are made for reexamination of training, support, and staffing levels as well as for greater attention to the design of equipment for maintainability. Greater coordination and control of ETS requirements and the increased use of NETS are recommended for greater efficiency.

Publications:	R. E. Boynton, "Preliminary Analysis of the Use of Contractor Engineering and Technical Services (CETS), NPS Technical Report, NPS 64-84-001 PR, October 1984.

Title: Experimental Test of a Demand Revealing
                      Mechanism and a Compensating Election for
                      Public Expenditure Decisions

Investigator: Earl R. Brubaker, Professor of Economics

Objective: To test the hypotheses that responses
                      to a demand revealing mechanism, and
                      to a compensating election will not
                      differ significantly from those to a
                      highest-rejected bid auction.

Summary: A detailed experiment was designed to
                      observe behavior in response to the
                      extremely promising collective purchase
                      decision procedures mentioned above The
                      experiment was designed to recruit DRMEC
                      participants as representative of mature
                      decision makers. Special care was taken
                      to create decision situations in-
                      corporating elements identified as
                      crucial by con-temporary public micro-
                      economic theory.

Title: Soviet Public Expenditure Decisions

Investigator: Earl R. Brubaker

Objective: To study Soviet public expenditure
                    decision procedures to learn: (1) who
                    participates and (2) how objectives
                    are defined, (3) what criteria are
                    used, (4) how the process might be
                    modeled and (5) how understanding
                    the process can facilitate explanation
                    and/or prediction of Soviet public
                    expenditure changes in response to
                    changing circumstances.

Summary: An extensive survey of bibliographic
                    references was conducted. collection of
                    pertinent materials was begun. Surveys
                    of relevant literature were drafted.

Title:	Group Decision Support System: An Advisory System for Bargaining and Negotiation
Investigator:	T. X. Bui, Assistant Professor of Information Systems
Sponsor:	NPS Foundation Research Program
Objective:	To develop algorithms for supporting group decision making and negotiation, and implement them in a computer-based decision support system for geographically dispersed players.

Summary: A consensus seeking algorithm for group decision support system--the Negotiable Alternatives Identifier (NAI)--was developed which can be used together with the techniques of aggregation of preferences. Departing from individual and cardinal rankings of alternatives, NAI uses differential techniques to group ranked alternatives into three classes of preferences: the most preferred, the preferred and the least preferred sets of alternatives. Within each class, infinitesimal differences in preferences between alternatives make it more confident for the decision makers to trade them. As a result, a collective decision that may not be necessarily unanimous, yet essentially acceptable by all can be suggested.

The developed algorithm was implemented on an IBM-PC XT and interfaced with Co-op, a Decision Support System (DSS) for cooperative multiple criteria group decision making. Early tests performed with students in a DSS class showed encouraging results.

Publications: T. X. Bui, "NAI: A Consensus Seeking Algorithm for Group Decision Support System," Proceedings of the IEEE International Conference of Man, Systems, and Cybernetics, 11-16 November 1985, Tucson, Arizona.

M. Jarke, T. X. Bui and T. Jelassi, "Micro-Mainframe DSS for Remote Multiperson Decisions," in M. Jarke, Managers, Micros and Mainframes, Chichester, England, John Wiley and Sons, to appear, 1986.

Conference Presentation: T. X. Bui, "Bargaining and Negotiation Issues in Group Decision Support Systems," NYU-University of Paris Dauphine IX, Workshop on Group Decision Support System, January 1985.

Title: Kalman Filtering "Estimation of
                    Unobserved Rational Expectations"

Investigators: E. Burmeister and K. D. Wall
                    (Co-Principal Investigators)

Sponsor: National Science Foundation

Summary: Grant was for an investigation into
                    the application of Kalman Filtering
                    in Econometrics. A new approach to
                    a classical problem in price ex-
                    pectation was treated in a novel way.
                    Work has branched out into financial
                    economics applications, and to
                    incorporating nonparametric testing
                    techniques in the analysis of state-
                    space models.

Title:	High Performing Systems in the Military: Defining Excellence in the Operational Forces
Investigators:	R. T. Harris, Associate Professor of Management and R. A. McGonigal, Associate Professor of Management
Sponsor:	NPS Foundation Research Program Naval Military Personnel Command (NMPC-6)
Objective:	To identify and describe the salient attributes of high performing military organizations and to determine the consensus views held by senior leaders within the military of what contributes to "excellence" in military organizations.
Summary:	Patterned after the bestseller, In Search of Excellence: Lessons from America's Best Run Companies, this major research project involves the examination and description of high performing military organizations. A series of studies have been undertaken, each focused on a different military community and each aimed at locating and describing excellence within that military community. Seven studies are completed. Three of the reports have received widespread positive visibility within their respective communities. Three more studies are currently in progress. The ten studies include: Navy surface ships, Navy fighter and attack squadrons, Navy hospitals, Navy operational staffs, Army combat arms battalions, Air Force fighter squadrons, and Marine Corp battalions and air squadrons. Generally, each study is conducted as a graduate thesis project involving one or more students from the communities/ service being studied. The transcripts of interviews conducted will be compiled and reported in a series of NPS technical reports.
Publication:	G. G. Gullickson, R. D. Chenette and R. T. Harris, "Excellence in the Surface Navy," NPS Technical Report, NPS54-84-026, October 1984.
Conference Presentations:	R. T. Harris, "Excellence and High Performance in the Military," Organizational Studies Symposium, Stockholm School of Economics, Stockholm, Sweden, 16 November 1984.

R. T. Harris, "Excellence and Change in Bureaucratic Organizations," University Associates Human Resource Development 1985 Conference, San Francisco, 28-29 March 1985. |

Title: J. Simonsen, D. Hoopengardner and H. Frandsen, "Excellence in the Combat Arms," <u>Master's Thesis</u>, December 1984.

S. Sigler, "Excellence in the VP Navy," <u>Master's Thesis</u>, December 1984.

J. Norton, "Excellence in Navy Health Care," <u>Master's Thesis</u>, December 1984.

M. Pierce and R. Porter, "Excellence in the Surface Coast Guard," <u>Master's Thesis</u>, December 1984.

H. Forde, "Excellence in Tactical Fighter Squadrons," <u>Master's Thesis</u>, June 1985.

H. Coffman, "Essence of Excellence: Lessons from Naval Executives about Superior Performing Tactical and Readiness Staffs," <u>Master's Thesis</u>, June 1985.

Title:	Element Selection and Array Tolerance Using Computer Optimization Techniques
Investigators:	J. P. Ignizio and W. J. Hughes
Sponsor:	Naval Sea Systems Command (Via Penn State)
Objective:	To determine an improved approach for acoustic array element selection and placement
Summary:	Study completed successfully in 1985. A new AI based approach was used to accomplish objective. Complete descriptions may be found in report
Publication:	Ignizio, J. P., Wieman, K., and Hughes, W. J. "An Expert Systems Approach to Acoustic Array Design", in preparation.
	Wieman, K., Hughes, W. J. and Ignizio, J. P. "An Algorithm for Selecting Transducer Element Array Positions", report to Naval Sea Systems Command and ARL, 147 pages.
Conference Presentation:	Ignizio, J. P., Wieman, K. and Hughes, W. J. "An Expert Systems Approach to Acoustic Array Design", to be presented at ORSA/TIMS, Los Angeles, 1986.
Theses Directed:	Wieman, K. "An Algorithm for Selecting Transducer Element Array Positions", Master's Thesis, Penn State, 1985.

Title:	Task Definition, Decision-Criteria and Uncertainty Reduction: The Role of the Agency Budget Office
Investigator:	J. L. McCaffery, Professor of Public Budgeting, Department of Administrative Sciences
Sponsor:	NPS Foundation Research Program
Objective:	To explore the behavior of budget offices with the intention of developing stable sets of inventories applied to budget decision-making. This is an on-going project focused on the Department of Navy Budget Office and the Department of Defense Planning-Programming-Budgeting system with comparisons made to other budget offices and processes.
Summary:	During this reporting period background research on issues impacting on budget office routines has led to an assessment of various phases of contemporary budget reforms. This paper will be published in the International Review of Public Administration, under the title "The Road to Reform of Process" in January 1986.
	A second paper focused on the executive budget process comparing routines in Canada and in California to see what sets of behavior were stable across very different institutional settings. This paper was presented at a symposium at the University of California, Berkeley. A revised version of this paper is under consideration by the Policy Studies Journal.
	Two further presentations extending this research are scheduled for this year, one on comparative budget systems at the Western Social Science Association in April 1986 and one on organizational strategies for increasing productivity at the Western Political Science Association in March 1986.
Publications:	J. L. McCaffery, "The Road to Reform of Process," International Journal of Public Administration, forthcoming.
	J. L. McCaffery, "Crossing Cultural Boundaries - Two Budget Systems," Policy Studies Journal, in review.
Conference Presentations:	J. L. McCaffery, "Comparison of State and Provincial Budget Systems with Ontario and California Used as Models," Workshop on Comparative Canada/U.S. Public Policy, University of California, Berkeley, 22-23 April 1985.

Title:	An Evaluation of Leasing as a Financing Strategy Within the Navy
Investigator:	J. G. San Miguel, Professor of Accounting
Sponsor:	NPS Foundation Research Program

Ojbective: The aim of this research was to evaluate the cost effectiveness of leasing as an alternative financing strategy for the Department of the Navy specifically and the Department of Defense generally. This evaluation of the efficacy of leasing was twofold: first, from the point of view of DON in achieving its overall objectives for the program for which the equipment was leased, and second, from the view of the overall operation of the U.S. government.

Summary: Recently both the Department of the Navy and the Department of Defense initiated plans to lease capital equipment as opposed to the use of appropriated funds to purchase capital equipment. Congress, the General Accounting Office, and the public have expressed concern on this initiative. Although usually far more complex, most leasing arrangements between an owner of capital equipment and someone who wishes to use the capital equipment are viewed as a "rental" arrangement. The DON's lease arrangements for thirteen ships for its Military Sealift Command are long-term contracts for "transportation services." The length of lease and renewable options, tax benefits, cancellation provisions (DON guarantees for legal fees and lost interest) involved in the agreements are extremely more complex. An exhaustive study of the extant literature was completed and numerous personal interviews conducted with individuals within DON and others knowledgeable in leasing and the shipbuilding industry.

Thesis Directed: R. E. Ratcliff, "A Framework for the Procurement of Assets Through Leasing Arrangements," Master's Thesis, December 1984.

Title:	Coupling Symbolic Reasoning and Numerical Computing Systems
Investigator:	T. R. Sivasankaran, Assistant Professor of Management Information Systems
Sponsor:	NPS Foundation Research Program
Objective:	Modeling and designing symbolic-numeric interfaces for an expert system. The long-term objectives include development of methods to integrate various technologies like expert systems, decision support systems, data base management systems and other operational systems into a single organizational computer system.
Summary:	The period covered by the sponsor was only two months. This time was spent in reviewing literature related to the research topic and developing a first-cut conceptual model for coupling the symbolic planning and numerical execution in an expert system in the domain of actuarial science.
Publication:	T. R. Sivasankaran and M. Jarke, "Coupling Expert Systems and Actuarial Pricing Models," Proceedings of the Workshop on Coupling Symbolic and Numerical Computing in Expert-Systems, Bellevue, Washington, August 1985. To be included in forthcoming publication by North-Holland Publishing Company.
Conference Presentation:	T. R. Sivasankaran and M. Jarke, "Coupling Expert Systems and Actuarial Pricing Models," Workshop on Coupling Symbolic and Numerical Computing in Expert Systems, Bellevue, Washington, August 1985.

Title: Use of the Rasch Model in Sequential Testing

Investigator: R. A. Weitzman, Associate Professor of Psychology

Sponsor: NPS Foundation Research Program

Objective: To improve the efficiency and the applicability of
                       sequential testing for selection of school or job
                       applicants through the use of the Rasch item-
                       response model.

Summary: Sequential testing for selection requires estimation
                       of the proportion of examinees in each test-score
                       group who get an item right. The Rasch model pro-
                       vides such an estimate. This research has developed
                       the procedure and is in the process of applying it
                       to the real data and preparing a report of the
                       results.

Publication: R. A. Weitzman, "The Rasch Model Plus Guessing,"
                       in progress. Will be submitted to the Journal of
                       Applied Psychology for possible publication.

DEPARTMENT

OF

AERONAUTICS

DEPARTMENT OF AERONAUTICS

During the reporting period, Aeronautics faculty have been active in the following major research areas:

AIRCRAFT COMBAT VULNERABILITY

Professor Ball continued his work in Aircraft Combat Vulnerability, conducting studies on nine different projects. These included combat lethality, air defense concepts and effectiveness, target vulnerability to air defense weapons, the world's first naval surface-to-air missile defense systems, air-to-air missile operations and effectiveness and aircraft survivability assessment in the conceptual design phase. Professor Ball's book, "The Fundamentals of Aircraft Combat Survivability Analysis and Design" was published by the American Institute of Aeronautics and Astronautics and offered for sale.

CONTROL OF FUEL INJECTION IN TURBINE COMBUSTORS

Professors Biblarz and Miller continued their work in the Electrohydrodynamic (EHD) control of fuel injection using a T-56 aircraft injector for the spray characteristics investigation and a T-56 injector and combustion can liner as a combustion apparatus. Although it has been possible to burn a non-design fuel such as diesel oil in the combustors, some difficulties have been encountered in maintaining electrode voltage in the presence of ionizing flame fronts.

SATELLITE VULNERABILITY TO HIGH ENERGY LASERS

Distinguished Professor Fuhs has continued work in his area of Satellite Vulnerabnility to High Energy Lasers (HEL) by completing two studies during this year. The trade-offs between spacecraft propulsion and laser power was investigated for a space-based laser, as were various aspects of spacecraft survivability.

SPACECRAFT CONTAMINATION FROM LASER EXHAUST

Alternative approaches to previously used methods for obtaining solutions for the span of flow from continuum through transitional to free-molecular flow were examined by Distinguished Professor Fuhs during 1985. These included using a "breakdown-surface" model and an integral approach, sometimes known as the BKG-Method. Solutions were obtained using both methods.

257

UNDERWATER SHAPED CHARGES

In a continuation of the effort to predict the behavior of metal jets from shaped charges fired underwater, the warheads designed by Distinguished Professor Fuhs' Underwater Shaped Charge team were fabricated and tested at NSWC/WOL. Temperature, velocity, burning times, particle size, and particle dynamics were measured for a series of metals.

SOLAR CELL RADIATION DAMAGE EFFECTS

The components for a Solar Cell Test Facility were procured and assembled by Distinguished Professor Fuhs. It is anticipated that in 1986 his facility will begin testing the performance degradation of Gallium Arsenide photovoltaic cells when exposed to a high energy electron flux.

HELICOPTER-SHIP INTERFACE

A study of the feasibility of simulating the land of an arbitrary helicopter on an arbitrary non-aviation ship in poor weather conditions was begun by Professor Healey. The objective of this study is to develop a realistic ship-helicopter-weather simulation that will permit determination of the 'corners-of-the-envelope' for certifying helicopter landings on 'small boys'.

SOLID FUEL RAM JET COMBUSTION

Experimental investigations have been continued by Professor Netzer to determine the effects of combustor geometry and flow conditions on the occurrence of combustion pressure oscillations. In addition, experiments demonstrated that metallized fuels produced efficiencies as high as those obtained with pure hydrocarbons.

FUEL EFFECTS ON COMBUSOR AND AUGMENTER TUB EMISSIONS

A gas turbine combustor test facility designed by Professor Netzer has been used to determine soot size and concentration in an effort to determine the effects of fuel compositions and additives on gas turbine emissions. In initial tests, Cerium hex-cam was found to increase the soot size in the exhaust duct with no change in mass concentration.

THE USE OF HOLOGRAMS IN SOLIC COMBUSTION DATA RETRIEVAL

Professor Netzer has completed the experimental set up to determine the use of Hologram sin automatic data retrieval for studying solid propellant combustion. Good quality Holograms have been obtained using a two-dimensional motor, but the speckle and non-uniform background illumination have made data reduction difficult. Currently Holograms are being attempted using a three-dimensional motor.

RELIABILITY CHARACTERISTICS OF COMPOSITE MATERIALS

Professor Wu, assisted by Adjunct Research Professor Own, is using mehcanics of materials techniques to quantitatively model composite material behavior to gain an understanding of the parametric roles of fiber and matrixes on the strength and durability of composites. Experimental measurements have been made on graphite/fiber, graphite/aluminum and graphite/epoxy composites.

COMPOSITES RELIABILITY CERTIFICATION METHODOLOGY

Uniaxial and combined-stress probabilistic strength and life determinations are being made by Professor Wu assisted by Adjunct Research Professor Own in order to develop test mewthods, data and theories that will contribute to the rational development of certification methodologies for fiber reinforced composite structures.

AGING CHARACTERISTICS OF COMPOSITES

The development of mechanical testing methodologies for tensive and shear properties of composites is required in order to permit quantification of the composites aging process. Professor Wu is designing a test facility that will permit this determination.

UNSTEADY FLOW AND AEROELASTICITY IN AIRCRAFT PROPULSION SYSTEMS

The steady and unsteady blade performance in axial-flow turbo machinery is beign ivestigated by Professor Platzer using Cebeci's inviscid/viscous interaction method. A unique nozzle (submitted as a patent disclosure) was designed and built and rested to determine its effectiveness on the entrainment of subsonic jets. The nozzle, when installed in an ejector system, produced a thrust augmentation ratio of 1.6 at an excitation frequency of 20 Hz.

Professor Platzer is serving a s co-editor of the AGARD Manual on Aeroelasticity in Axial Turbomachines. Volume 1 of this Manual will be submitted in April 1986.

TWO-DIMENSIONAL CASCADE FLOWS AND OSCILLATORY JETS

Professor Collins has made preliminary measurements on a cascade using a Laser Doppler Anemometer (LDA) in order to obtain experimental data on flow fields in turbomachinery. These data will then be compared with numerical predictions.

A file has been made by Professors Collins and Platzer to show the new augmentor arrangement for the oscillating jet.

TURBOPROPULSION

Professor Shreeve, the Director of the NPS Turbopropulsin Laboratory, and his collaborators are studying propulsion problems ranging from the numerical simulation of internal flows, the development of a transonic compressor model, the development of a centrifugal diffuser test device and the investigation of compressor tip clearance effects to the study of wave rotors, wave engines and detonation pulse engines.

Title: Aircraft Combat Survivability

Investigator(s):   R. E. Ball, Professor, Department of Aeronautics

Sponsor: Naval Air Systems Command and the JTCJ/AS

Objective: To conduct studies and develop educational
                          material in aircraft combat survivability.

Summary: Studies were conducted on nine different pro-
                          jects the past year. These included combat
                          lethality, air defense concepts and effective-
                          ness, target vulnerability to air defense
                          weapons, the world's naval surface-to-air
                          missile defense systems, air to air missile
                          operations and effectiveness, and aircraft
                          survivability assessment in the conceptual
                          design phase.

Title:	Experimental Measurements of Two-Dimensional Cascade Flows and Oscillatory Jets
Investigator(s):	D. J. Collins
Sponsor:	Naval Air Systems Command
Objective:	Compare measured flow fields in turbomachinery with numerical predictions.
Summary:	LDA equipment has been setup on cascade. Some preliminary measurements have been made. In the oscillating jet a film has been produced with Professor Platzer on new augmentor arranmgement.
Theses Directed:	On Two-Dimensional Cascade Measurement; in process of being written.

Title: Satellite Vulnerability to High Energy Lasers

Investigator: A. E. Fuhs, Distinguished Professor of Aeronautics

Sponsor: Naval Space and Warfare Systems Command

Objective: The project has two objectives. First, a specific
                        USN satellite will be studied for vulnerability to
                        a SOVIET laser. Second, a range of lasers, basing
                        modes, and satellites will be investigated.

Summary: The research was initiated in FY83. During FY85
                        several studies were completed. In our study the
                        tradeoff between spacecraft propulsion and laser
                        power was investigated for a space based laser.
                        Another study examined aspects of spacecraft
                        survivability . Various optical problems associated
                        with ground based ASAT HEL were studied.

Theses Directed: E. L. Dziura, "Satellite Vulnerability to High
                        Energy Lasers", Master's Thesis, March 1985.

                        B. Shell, "Tradeoff Between Laser Power and
                        Spacecraft Propulsion for a Space Based Laser",
                        Master's Thesis, June 1985.

                        B. N. Lanzer, "Experimental and Theoretical
                        Investigation of Satellite Optical Tracking,
                        Master's Thesis, June 1985.

Title: Solar Cell Radiation Damage Effects

Investigator: A. E. Fuhs, Distinguished Professor of Aeronautics

Sponsor: Naval Space and Warfare Systems Commmand

Objective: To determine the performance degradation of Gallium
                          Arsenide photovoltaic cells when exposed to a high
                          energy electron flux.

Summary: The project was initiated in FY84 by funding from
                          NPS to create a Solar Cell Test Facitity. In FY85
                          components for the test facility were purchased and
                          assembled. The test facility is operational except
                          for spectral measurements of the test lamp and for
                          calibration of the irradiance from the test lamp.
                          GaAs cells were purchased for tests in FY86.

Thesis Technical   K.T. Mabie, "Solar Simulation Laboratory Description
Report: and Manual, NPS-67-85-006, June 1985.

Title: Spacecraft Contamination from Laser Exhaust

Investigator: A. E. Fuhs, Distinguished Professor of Aeronautics

Sponsor: Strategic Defense Initiative Office/Directed Energy
                    Office, SDIO/DIO

Objective: To determine the flux of backscattered molecules
                    when an open cycle laser is fired from a spacecraft.

Summary: The project was initiated late in FY82 with several
                    man-days effort for a literature survey. In FY83
                    computer codes for solving the span of flow from
                    continuum through transitional to free-molecular
                    flow were examined. The Monte Carlo technique was
                    selected as the best approach for a numerical
                    solution. During FY84, a Monte Carlo computer
                    program was written by Dr. Shaul Abramovich who was
                    at the Naval Postgraduate School on sabbatical from
                    Israel. A submodule of the program was an
                    axisymmetric method of characteristics (MOC)
                    program. The Monte Carlo program required extensive
                    computer time. In FY85 alternate approaches for
                    obtaining solutions were examined including a
                    "breakdown-surface" model and an integral approach
                    sometimes known as BKG-Method. Solutions were
                    obtained using both methods.

Contract Support   Contractor, J. Falcovitz; Contract Number N62271-84-
for Research: M-3345.

Contract Report: S .Abramovich, "Gas Dynamics of Laser Exhaust
                    External to Spacecraft", NPS-67-85.

                    J. Falcovitz, "Spacecraft Contamination from a
                    Chemical Laser Ring Jet-- A Progress Report", August
                    1985.

Publication: S. Abramovich and A. E. Fuhs, "Some Characteristics
                    of Isentropic Plumes of Underexpanded Free Jets,
                    AIAA Paper 85-0048, 1985.

                    S. E. McCarty, A. E. Fuhs, and J. Falcovitz, "A
                    Breakdown Surface Model for Thermal Backscattering
                    from the Exhaust Plume of a Space-Based Chemical
                    Laser", Submitted to the Journal of Spacecraft and
                    Rockets.

Thesis Technical   S. E. McCarty, "Molecular Back Flow from the Exhaust
report: Plume of a space-Based Laser", NPS-67-85-003

Title:	Underwater Shaped Charges
Investigator:	A. E. Fuhs, Distinguished Professor of Aeronautics
Sponsor:	Naval Surface Weapons Center/White Oak Laboratories
Objectives:	The project has two objectives as follows: First, an understanding of metal-steam combustion is needed, and, second, an ability to predict behavior metal jets from shaped charges fired underwater is to be developed.

Summary: Penetration of the metal jet from an underwater shaped charge generates a vapor cavity and a bow shock wave. The metal jet penetrates supersonically relative to the water causing intense shock waves (10000 atmospheres). Under certain circumstances, the metal jet reacts vigorously with the water releasing considerable chemical energy. The project was initiated in FY82. A summary of activity is given to provide background information:

Year	Activity
FY82	A series of tests were conducted at NSWC/WOL involving shaped charges of NPS design. The warheads were conceived, designed, and tested by NPS project personnel. NWSC/WOL fabricated the shaped charges.
FY83	Apparatus for exploding wires in a steam or other atomosphere was designed, built, and calibrated. A new laboratory was created in the Control Room of the Jet Engine Test Cells. Tests were conducted of aluminum burning in steam and air. A computer program was initiated for supersonic flow in water.
FY84	Work was initiated on a new series of warheads to be tested at NWSC/WOL. NPS project personnel designed the shaped charges. The warhead tests were scheduled for FY85. In the Torpedo Warhead Laboratory, the temperature of burning metal particles was measured.
FY85	The warheads designed and fabricated were tested at NWSC/WOL. Temperature, velocity, burning times, particle sizes, and particle dynamics were measured for a series of metals.

266

Publication: A. E. Fuhs, J. Buck, A. E. Hollenbech, Jr., and J. Strott, "Combustion in Steam", American Society of Naval Engineers Journal, Vol. 97, March 1985, pp 65-79.

Thesis Technical Reports: D. L. Cousins and M. S. Kosiek, "Experimental Investigation of Shaped Charge Reactive Metal Liners for Underwater Ordnance", NPS-67-84-012, December 1984.

Contracts for Research Support to Effort: Contractor, J. Kol; Contract Numbers N62271-83-M-2041 and N62271-84-M-3055.

Contractor, Y. Chosev; Contract Number N62271-84-M-3357.

Technical Reports: J. Kol, A. E. Fuhs, and M. Berger, "Experimental Investigation of Aluminum Combustion in Steam", AIAA Aerospace Sciences Meeting, Reno, NV, January 1985, AIAA Paper 85-0323.

M. Berger, A. E. Fuhs, and J. Kol, "Two-Color Photo-Pyrometer Method for Temperature Measurement of Moving Burning Particles", AIAA Aerospace Sciences Meeting, Reno, NV, January 1985, AIAA Paper 85-0157.

Y. Chozev and J. Kol, "Experimental Investigation of Magnesium Combustion in Steam, NPS-67-85-004CR, July 1985.

J. Kol and Y. Chozev, "Experimental Investigation of Aluminum Combustion in Sulfur Hexafluoride Atmosphere", NPS-67-85-001CR, July 1985.

J. Kol, Y. Chozev, and M. Berger, "Preliminary Results of Velocities and Deceleration of Aluminum, Magnesium, Zirconium, Tantalum, Pyrofuze, and Titanium Particles Burning in Steam", NPS-67-85-005CR, July 1985.

Y. Chozev and J. Kol, "Burning Time and Size of Aluminum, Magnesium, Zirconium, Tantalum, and Pyrofuze Particles Burning in Steam", NPS-67-85-004CR, July 1985.

Title: Metallized Fuel Ramjet Combustion

Investigators: A. Gany, NRC Postdoctoral Associate and
                          D. W. Netzer, Professor of Aeronautics

Sponsor: National Research Council/NPS Foundation Research
                          Program

Objective: Conduct fundamental experimental and analytical
                          studies to enhance the understanding of the
                          combustion behavior of ramjets that utilize large
                          mass fractions of metal within the solid fuel.

Summary: Thermochemical evaluation of fuel candidates
                          for ramjet propulsion was made in terms of the
                          theoretical heat of combustion per unit mass and
                          per unit volume of the fuel. Compared with the
                          commonly used hydrocarbons, the main advantage of
                          using metals or metal compounds is their much
                          higher energy density, which is of great signifi-
                          cance in volume limited systems. For practical
                          use, boron has the highest energy density of all
                          elements (almost three times higher than that of
                          hydrocarbons). However, several boron compounds
                          exhibit similar theoretical performance,
                          especially boron carbide and the high borides of
                          of aluminum, magnesium, and silicon.

                          Combustion phenomena of highly metallized, boron
                          containing, solid fuels in solid fuel ramjets
                          (SFRJ) were studied by means of high speed photo-
                          graphy using a windowed two-dimensional SFRJ
                          combustor. The experiments indicated the
                          existence of a gas phase diffusion flame of the
                          volatile fuel ingredients within the boundary
                          layer above the fuel surface. It was also
                          revealed that material is often emitted from
                          the surface in the form of large pieces and
                          segments. Flow impingement on the surface may
                          cause surface heating and glowing by chemical
                          reactions, which promote the high speed ejection
                          of hot particles and the emittance and disinte-
                          gration of large glowing segmenmts and pieces
                          from the fuel surface layer to the gas stream.

Publications: A. Gany and D. W. Netzer, "Thermochemical Evaluation of Fuel Candidate, for Ramjet Propulsion", in Proceedings of the 27th Israel Conference on Aviation and Astronautics, pp. 210-219, February, 1985.

A. Gany and D. W. Netzer, "Combustion Studies of Metallized Fuels for Solid Fuel Ramjets", AIAA-85-1177, AIAA/SAE/ASME/ASEE 21st Joint Propulsion Conference, July 8-10, 1985.

A. Gany and D. W. Netzer, "Fuel Performance Evaluation for the Solid-Fueled Ramjet", NPS Report 67-84-012, October, 1984.

Conference   A. Gany and D. W. Netzer, "Thermochemical Evaluation of Fuel Candidate, for Ramjet Propulsion," 27th Israel Conference on Aviation and Astronautics, February 1985.

A. Gany and D. W. Netzer, "Combustion Studies of Metallized Fuels for Solid Fuel Ramjets," AIAA/SAE/ASME/ASEE 21st Joint Propulsion Conference, July 8-10, 1985.

Title: Helicopter-ship Interface Study

Investigator(s):   J. V. Healey, Associate Professor of
                                Aeronautics

Sponsor: Naval Air Systems Command

Objective: To determine the feasibility of simulating
                                the landing of an arbitrary helicopter or an
                                arbitrary non-aviation ship in poor weather
                                conditions.

Summary: The approach to this study, which was started
                                in Summer 1985, was to break down the
                                investigation into several steps.

                                1. Determine the probable velocity profile and
                                turbulece statistics for the free-stream
                                airflow to the ship.

                                2. Asess the current ability to predict the
                                motion of an arbitrary ship in extremely rough
                                sea conditions.

                                3. Investigate the nature of the airflow
                                around the ship and the likelihood of
                                predicting it.

                                4. Examine the current status of turbulence
                                modeling of helicopters.

                                5. If all four of above indicate the possi-
                                bility of simulation of the landing, determine
                                the necessary parameters.

                                The Summer quarter was spent on literature and
                                data base searches, familiarization with the
                                methods of ship motion analysis and discussions
                                with researchers in U.S. and Europe.

Title: Electrohydrodynamic Control of Fuel Injection in
Gas Turbine Combustors

Investigator(s):   J. A. Miller, Associate Professor of Aeronautics
and O. Biblarz, Associate Professor of
Aeronautics

Sponsor: Naval Air Systems Command

Objective: This program evaluates the merits of electrodyro-
dynamically-modulated fuel injection for gas tur-
bine combustors. Fuel injection spray charac-
teristics are being studied with an optical tech-
nique and the effects on combustion are being
evaluated from measurements of combustion product
temperatures. The goal of this program is to
evolve practical means of using electrostatic
elements within the combustion chamber to control
fuel spray characteristics and thus optimize com-
bustion efficiency for a variety of gas turbine
fuels. The electrical probes considered are
rugged and may be inserted with minimum penalty
during engine overhaul.

Summary: A T-56 aircraft injector has been employed in the
spray characteristics investigation and aT-56
injector and combustion-can liner have been
incorporated into a combusiton apparatus.
Results indicate that a centerline electrode
charged with voltages typical of spark plugs
($\sim$30kV)), is capable of producing large charges
in fuel spray characteristics. It has been
possible to burn a non-design fuel such as diesel
in the combustors. Some practical difficulties
in maintaining electrode voltage in the presence
of ionizing flame fronts has been encountered and
a development program to overcome this difficulty
has been underway. Additionally, studies are
being conducted to better understand the effects
of electrostatic fields on spray characteristic
modification. The combustor has been run at
higher pressures. The optical measurement device
has been calibrated and run with various sprays.

Conference
Presentation(s):   J. Powers, Z. Shavit, O. Biblarz, and J. A.
                          Miller, "Variable Length Radiometer for Particle
                          Sizing," ICIASF '85, Stanford Aug '85.

These Directed: None.

Patent Application(s):   (i) O. Biblarz, J.A. Miller, and R.J. Laib,
                              "Electrohydrodynamics (EHD) Control of
                              Fuel Injection in Gas Turbines,"
                              Patent No. 4,439,980 (4/3/84).

                          (ii) J. Powers, O. Biblarz, and J. Miller,
                               "Precision Variable Focal Length Radiometer
                               for Particle Sizing," Applied 5/4/85,
                               Navy Case No. 69,120

272

Title:	Fuel Composition and Additive Effects on Combustor and Augmentor Tube Emissions
Investigator:	D. W. Netzer, Professor of Aeronautics
Sponsor:	Naval Air Propulsion Center
Objective:	Experimentally investigate the combustion mechanisms of smoke suppressant fuel additives and the effects of JP fuel composition by evaluating their effects on the distribution of temperature, carbon particle size and concentration and Nox concentrations within a gas turbine engine combustion chamber and the exhaust augmentor tube.
Summary:	A gas turbine combustor test facility has been designed, constructed, and utilized in this investigation. Three-wavelength light transmission measurements and measurements of forward scattered light at two angles are being used to determine soot size and concentration both within the conbustor and the exhaust duct of a T-G3 combustor. Thermocouple and gas sampling probes are also utilized.

In initial tests, Cerium hex-cem was found to increase the soot size in the exhaust duct with no change in mass concentration. |
Publications:	R. W. Dubeau, P. J. Hickey, A. C. King, A. L. Lohman, J. P. Wellor, and D. W. Netzer, "An Investigation of the Effects of Fuel Composition on Combustion Characteristics in a T-G3 Combustor", Naval Postgraduate School Report, NPS67-85-004, March, 1985.
Conference Presentations:	J. Bramer, R. Dubeau, P. J. Hickey, A. C. King, A. L. Lohman, J. P. Wellor, and D. W. Netzer, "Fuel Composition and Additive Effects on Soot Production", NAPC Particulate Emission Meeting, Monterey, CA, April 16-18, 1985.
Theses Directed:	J. S. Bennett, "An Investigation of Particle Size Measurement Using Non-Intrusive Optical Techniques in a Gas Turbine Combustor", Master's Thesis, September 1985.

Conference
Presentations:

A. Gany and D. W. Netzer, "Thermochemical
Evaluation of Fuel Candidate,
for Ramjet Propul-
sion, 27th Israel Conference on Aviation and
Astronautics, February 1985.

A. Gany and D. W. Netzer, "Combustion Studies of
Metallized Fuels for Solid Fuel Ramjets",
AIAA/SAE/ASME/ASEE 21st Joint Propulsion
Conference, July 8-10, 1985.

Title:	Solid Fuel Ramjet Combustion

Investigator:	D. W. Netzer, Professor of Aeronautics

Sponsor:	Naval Weapons Center

Objectives:

1. To determine the effects of combustor geometry and flow conditions on the occurrance of combustion pressure oscillations.

2. To examine techniques for fuel regression rate control.

3. To compare the attainable performance of hydrocarbon fuels with several metallized fuel compositions.

4. To model the three-dimensional SFRJ combustion process.

Summary:

This is a continuing investigation. During FY85 the major emphasis has been on objectives 1 - 3.

An experimental investigation of the mechanisms involved in combustion pressure oscillations in bypass flow configured solid fuel ramjets was conducted. Testing was done using cylindrically perforated polymethylmethacrylate fuel grains in a solid fuel ramjet with 180^G opposed dumps into a plenum ahead of an axial dump combustor inlet. Bypass flow into the aft mixing chamber was accomplished using two dumps located either 180° or 90° apart, perpendicular to the centerline. Split inlet feed line lengths into the plenum were varied with no apparent change of the dominant pressure oscillation frequency of approximately 167 hz for bypass tests. Hot wire measurements indicated that in the short-coupled axial inlet, there were no dominant vortex shedding frequencies in the separation/shear layer or at the reattachment point on the fuel grain wall. The observed pressure osciallation frequency did not appear to be related to vortex shedding from the inlet jet. Coupling of the

driving disturbance from bypass flow could possibly be with a longitudinal mode of the combustor or a Helmholtz mode involving the head section plenum.

An experimental investigation was conducted to examine fuel regresion rate control methods other than variable bypass air flow rates in the solid fuel ramjet. Air and oxygen injection at various axial locations within the fuel grain were examined as well as air, oxygen and ethylene injection through the step face. Inlet swirl designs were also tested. Secondary gas injection was found to be inadequate for regression rate control.

A series of reacting flow tests of a solid fuel ramjet were conducted with different air inlet swirl. Cold flow measurements of the air flow at the exit plane of the tube-in-hole injector were used to determine the Swirl Number for each configuration. Regression rates fo the HTPB fuel at low air mass flux were found to increase significantly with swirl vane angle (and Swirl Number) up to 30 degrees.

Metallized fuels were found to produce combustion efficiencies as high as those obtained with pure hydrocarbons.

Publications:

T. M. Parafiorito and D. W. Netzer, "Combustion Pressure Oscillations in Solid Fuel Ramjets", in Proceedings of the 21st JANNAF Combustion Meeting, CPIA Pub. 412, Vol. II, pp. 679-687, Laurel, MD, October, 1984.

T. Milshtein and D. W. Netzer, "Three-Dimensional, Primitive Variable Model for Solid-Fuel Ramjet Combustion, to appear in the Journal of Propulsion and Power.

Conference Presentations:

T. M. Parafiorito and D. W. Netzer, "Combustion Pressure Oscillations in Solid Fuel Ramjets", 21st JANNAF Combustion Meeting, Laurel, MD, October 1-4, 1984.

Theses
Directed:

B. N. Ko, "An Experimental Investigation of Fuel
Regression Rate Control in Solid Fuel Ramjets",
Master's Thesis, September, 1985.

D. C. Rigterink, "An Experimental Investigation
of Combustion Pressure Oscillations in By-pass
Configured Solid Fuel Ramjets", Master's Thesis,
September, 1985.

W. H. Campbell, Jr., "An experimental Investiga-
tion of the Effects of Swirling Air Flows on
the Combustion Properties of a Solid Fuel Ramjet
Motor", Master's Thesis, September, 1985.

277

Title: Solid Propellant Combustion/Automatic Data
Retrieval from Holograms

Investigators: D.W. Netzer, Professor of Aeronautics and
J.P. Powers, Professor of Electrical and
Computer Engineering

Sponsor: Air Force Rocket Propulsion Laboratory

Objective: Conduct an experimental investigation of the
effects of solid propellant properties and motor
operating conditions on metallized particulates
within the combustor and exhaust nozzle. The
techniques investigated are: high speed motion
pictures, light scattering, scanning electron
microscopy, and optical holography.

Summary: A Quantimet 720 image processing system was
interfaced with a PDP 11/04 computer controller
for the purpose of automating the particle sizing
and locating operation. Hardware and software
problems in the Quantimet system were identified
and repaired. Preliminary tests results were
obtained from a calibration target illuminated
with white light. Hologram images of the
calibration target and actual particles in the
rocket motor were studied, but increased contrast
is required to use the holograms successfully.
A PC/AT image processing system was identified
and purchased to allow investigation of contrast
enhancement techniques and smoothing algorithms
to suppress speckle effects in the hologram
reconstructions.

In FY 85 final development of the light scatter-
ing apparatus is being completed and a parametric
test series conducted in which chamber pressure
and aluminum mass concentration are being varied
to determine the effects on charges on D_{32} across
the exhaust nozzle. These data are being com-
pared to the empirical equation presently used
for exhaust particle size in the SPP model.

Good quality holograms have been obtained using a
two-dimensional motor but speckle and non-uniform
background illumination (due to small particles/
smoke) have made data reduction difficult.
Currently, holograms are being attempted in a
small three-dimensional motor.

Publications: D. W. Netzer, J. P. Powers, J. Glenn, K. Graham,
R. Harris, Netzer, J. Powers, J. Glenn, K.Graham,
R Harris, and Y. Lee, "Solid Propellant Combus-
tion Diagnostics and Automated Data Retrieval
from Holograms" in Proceedings of the 21st JANNAF
Combustion Meeting, CPIA Pub. 412, Vol. I,
pp. 1-14, Laurel, MD, October, 1984.

D. W. Netzer and J. P. Powers, "Particle Sizing
in Rocket Motor Studies Utilizing Hologram Image
Processing" in Proceedings of the Workshop on
Automated Data Reduction from Images and
Holograms, (NASA Ames Research Center, Mountain
View, CA), forthcoming.

Conference D. W. Netzer, J. P. Powers, J. Glenn, K. Graham,
Presentations: R. Harris, and Y. Lee, "Solid Propellant Combus-
tion Diagnostics and Automated Data Retrieval
from Holograms", 21st JANNAF Combustion Meeting,
Laurel, MD, October 1984.

D. W. Netzer and J. P. Powers, "Particle Sizing
in Rocket Motor Studies Utilizing Hologram Image
Processing."

D. W. Netzer and J. P. Powers, "Experimental
Techniques for Obtaining Particle Behavior in
Solid Propellant Combustion", AGARD Specialists
Meeting on Smokeless Propellants, Florence,
Italy, 12 and 13 September, 1985.

J. P. Powers and D. W. Netzer, "Combustion/
Particle Sizing Experiments at the Naval Post-
graduate School Combustion Research Laboratory",
Workshop on Automated Data Reduction from Images
and Holograms, Mountain View, CA, January 1985.

Thesis A. Kertadidjaja, "Particle Sizing in a Solid
Directed: Rocket Motor Using the Measurement of Scattered
Light", Master's Thesis, March, 1985.

J. S. Rosa, "Particle Sizing in Solid Rocket
Motor Exhaust Nozzles", Aeronautical Engineer's
Thesis, Forthcoming.

S. C. Yoon, "Particulate Sizing in Solid Propel-
lant Rocket Motors Using Holography", Master's
Thesis, Forthcoming.

M. P. Shook, Computer Controlled Image Analysis
Analysis of Solid Propellant Combustion Holograms
Using a Quantimet 720 and PDP-11", Master's
Thesis, September, 1985.

279

Title: Investigation of Unsteady Flow and Aeroelastic
                                Problems in Aircraft Propulsion Systems

Investigator(s):   Professor M. F. Platzer

Sponsor: Naval Air Systems Command

Objective: The objective of this work unit is threefold:

                                1) To analyze the steady and unsteady blade
                                    performance in axial-flow turbomachinery,
                                    including subsonic, transonic, and super-
                                    sonic flows.

                                2) To measure the effectiveness of a new jet
                                    excitation mechanism on the entrainment of
                                    subsonic jets.

                                3) To serve as co-editor of the AGARD Manual on
                                    Aeroelasticity in Axial Turbomachines.

Summary: Task 1) is being pursued using Cebeci's inviscid/
                                viscous interaction method. First, an inviscid
                                method is used to compute the flow about the con-
                                figuration with a zero normal velocity boundary
                                condition. The resulting pressure distribution
                                serves as input to a boundary-layer method which
                                calculates all relevant boundary-layer para-
                                meters, including a surface blowing distribution
                                to simulate the displacement thickness effect and
                                to resolve the inviscid flow equations with a
                                condition that the normal velocity on the surface
                                equals the blowing velocity. The new pressure
                                distribution is again used as input to the
                                boundary-layer method and the procedure is re-
                                peated until convergence.

                                Task 2) yielded the following results: A new
                                nozzle was designed and built. The novel feature
                                of this nozzle was submitted as a patent dis-
                                closure. Tests were completed to measure the
                                nozzle/ejector performance and to visualize the
                                flow mechanism. The nozzle when installed in an
                                ejector system produced a thrust augmentation
                                ratio of 1.6 at an excitation frequency of 20 Hz.

The results are documented in one NPS Report and two theses.

Task 3) was continued on schedule. Volume I of the AGARD Manual is expected to be submitted in April 1986.

Theses Directed: H. Wiradimadja, "Experimental Investigation of a Thrust Augmenting Ejector," M. S. Thesis, DEC 1985.

M. E. Rickenbaker, Jr., "A Comprehensive Review of V/STOL Propulsion Systems," M. S. Thesis, DEC 1985.

W. L. Posnett, III, "Applicaiton of AIBF/Vectored Thrust Hybrid Powered-Lift System to a Conceptual Design of an S-3 STOVL Aircraft," Engineer's Thesis, JUNE 1985.

Patent Application(s): A Novel Oscillating Jet Nozzle by M. F. Platzer submitted January 1986.

Title:	Aging Characterization of Composites
Investigator(s):	Edward M. Wu, Professor of Aeronautics
Sponsor:	Naval Surface Weapon Center
Objective:	The objective of this program is to provide mechanical testing methodology for tensile and shear properties of composites for quantification of aging of composites used in the D-5.
Summary:	True uniaxial shear test for composites require tubular samples subjected to torsion. Specimens for such tests are costly and the experimental implementation is very complicated. Test method using flat samples will be more compact, and lend itself to many aging experimental conditions. The development of an appropriate shear testing fixture will reduce the cost and the time for monitoring strength degradation associated with aging.

The following tasks will be investigated:

(a) Design and supply drawings for a fixture for testing composite shear strength using flat samples.

(b) Supply the proper method of data analysis.

(c) Provide consultation on experimental planning for aging characterization.

Title: Composites Reliability Certification Methodology

Investigator(s):   Edward M. Wu, Professor of Aeronautics and
                            S. H. Own, Research Professor of Aeronautics

Sponsor: Naval Air Systems Command - Cost Share 1/3
                            NPS Research Foundation   - Cost Share 2/3

Objective: The objective of this program is to conduct
                            coordinated experimental and analytical investi-
                            gations which will provide test methods, data,
                            and theories contributing to the rational devel-
                            opment of certification methodology for fiber
                            reinforced composites structures.

Summary: Application of fiber reinforced composites to
                            gain performance improvement in advanced struc-
                            tures requires theory and materials data for
                            design and for certification. We address the
                            accept or reject process based on the expected
                            composite strength and durability of the com-
                            posite by quantifying the statistical strength
                            and life of composite under uniaxial stress and
                            under combined stress.

                            Specifically, this program includes treatment
                            of:

                            (a) Uniaxial probabilistic strength and life
                                including model identification, single
                                fiber filament testing and single filament
                                composite testing.

                            (b) Combined-stress probabilistic strength and
                                life including theoretical modeling, experi-
                                mental data generation and computer software
                                implementation for applications.

Conference   S. H. Own, "A Statistical Formulation of Com-
Presentation: posite Strength Distribution: Fiber, Matrix,
                            and Interface ," Gordon Research Conference on
                            Composites, Santa Barbara, CA, Jan. 13-17, 1986.

Title: Reliability Characterization of Composite
                           Materials

Investigator(s):   E. M. Wu, Professor (Principle Investigator), and
                           S. H. Own, Adjunct Research Professor, Department
                           of Aeronautics

Sponsor: Army Materials and Mechanics Research Center

Objective: To provide the data base, interpretation,
                           methodology for quantitative measurements of the
                           reliability parameters which are needed in the
                           application of advanced composite materials in
                           high performance structures.

Summary: Experimental measurements and Statistical
                           characterization of the graphite/epoxy composites
                           have been performed. Size effect and statistical
                           strength model were extensively investigated.
                           The need for investigation bimodality of the fiber
                           and composite strength was identified.
                           Reliability models based on chain-of-bundle model
                           with local load sharing was investigated and more
                           realistic model was under development.

Publication(s):   S. H. Own, R. V. Subramanian, and S. C. Saunders,
                           "A Bimodal Lognormal Model of the Distribution of
                           Strength of Carbon Fibers" Effect of Electro-
                           deposition of Di (Dioctyl Pyrophosphate)
                           Oxyacetate", Journal of Materials Science,
                           (Accepted)

                           E. M. Wu and S. C. Chou, "Statistical Strength
                           Comparison of Metal-Matrix and Polymeric-Matrix
                           Composites," ASTM, Metal Matrix Composites, in
                           press, 1985.

Conference   "Stastical Tensile Strength of Metal Matrix
Presentation(s):   Composites," ASTM Metal Matrix Composites
                           Symposium, Nashville, TN, Nov. 19, 1985.

Thesis Directed: LT T. A. Bennett, A Comparison of Two Methods
                           for Fiber Diameter Measurement and a System
                           Design for the Study of Composite Reliability,
                           M.S. 1985.

284

DEPARTMENT

OF

OCEANOGRAPHY

DEPARTMENT OF OCEANOGRAPHY

The research program of the Department of Oceanography covers studies in five areas: coastal ocean, nearshore, arctic, open ocean, and ocean acoustics.

COASTAL OCEAN STUDIES

E. C. Haderlie studies the biology of stone and wood boring organisms in the deeper waters of Monterey Bay. His purpose is to determine and identify the vertical and horizontal distribution of these borers as well as their growth rates, settlement times, and destructive effects. The sponsor is the Office of Naval Research. He also studies the interannual variability in phytoplankton of Monterey Bay. The sponsor is the NPS Research Foundation.

NEARSHORE STUDIES

E. B. Thornton is studying the kinematics and energetics of breaking waves in the surf zone. His research is based on measurements of water particle motion within the surf zone. The sponsor is the Office of Naval Research.

E. B. Thornton is also transitioning a sea and swell model to a tactical application program. The sponsor is NEPRF.

ARCTIC STUDIES

R. H. Bourke and R. G. Paquette use U.S. Coast Guard icebreakers to observe and analyze ocean fronts and thermal fine-structure near the ice margin in the East Greenland Current. These studies have applications for environmental acoustics and under-ice submarine operations. The sponsors are the Arctic Submarine Laboratory, NOSC, and NSWC.

OPEN OCEAN STUDIES

R. W. Garwood's investigations of the response of the ocean surface turbulent boundary layer to atmospheric forcing have led to the development of models that can be used to compute upper ocean thermal structure changes if the atmospheric conditions are known. The studies have been extended into the equatorial ocean. The sponsors are the Office of Naval Research and the NPS Research Foundation.

E. B. Thornton and T. P. Stanton are studying the properties of velocity shears and density gradients in the upper ocean. The sponsor is the Office of Naval Research.

J. L. Mueller is investigating the effects of horizontal variability in ocean properties on the validity of optical propagation predictions based on one-dimensional models of the upper ocean. The R/V ACANIA is used, especially in the large field experiment called ODEX. This is part of a Selected Research Opportunity (SRO) program sponsored by ONR in support of the proposed Strategic Laser Communications (SLC) system. He also provides technical oversight to NROSS ground data processing development. The sponsor is NEPRF.

T. R. Osborn and R. G. Lueck are designing, building, testing and using horizontal and vertical sampling systems for ocean turbulence. They make measurements from ships (including the R/V ACANIA) and submarines, and in the North Atlantic, North Pacific, and Equatorial Pacific. The sponsors are the Office of Naval Research, NORDA, and National Science Foundation.

C. N. K. Mooers, M. M. Rienecker, and E. A. Kelley are conducting an ocean prediction study in collaboration with Harvard using the Harvard statistical-dynamical model for open domains. Their study is presently focused on eddies, fronts, and jets in the California Current System. Twenty synoptic realizations of the upper ocean have been acquired with oceanographic sampling from the R/V ACANIA and other vessels and planes. The sponsor is the Office of Naval Research.

OCEAN ACOUSTICS

G. H. Jung, R. H. Bourke, C. R. Dunlap, S. W. Yoon, A. B. Coppens, and T. F. Clarke study relations between atmospheric and oceanic variations and long-range, low-frequency sound propagation and ambient noise in the North Pacific Ocean. Satellite IR imagery is used to infer and interpret oceanic and acoustic variability. The sponsors are SPAWAR, NAVELEX, and NORDA.

C. R. Dunlap and R. H. Bourke are studying the performance of vertical line array sensors. The sponsor is ASW Systems Project Office; NAVAIR.

C. R. Dunlap, E. C. Haderlie, and J. P. Powers are investigating the effects of the ocean on fiber optic cables to be used in fixed distributed acoustic systems. The sponsors are SPAWAR and DARPA.

R. H. Bourke and C. R. Dunlap are advising student theses on acoustic topics in the Arctic Ocean. The sponsor is NSWC.

Title: Chair in Arctic Marine Science

Investigators: R.H. Bourke, Associate Professor of Oceanography
                    H.J. Niebauer, Adjunct Research Professor

Sponsor: Office of Naval Research

Objectives: To foster oceanographic research in the Arctic,
                    acquaint naval officer students with Arctic
                    problems, reduce results of pure research to
                    operational usage, and publicize Navy interest
                    in the Arctic.

Summary: Professor Bourke served as administrator of the
                    Chair handling such details as selecting Chair
                    candidates, writing IPA's and proposals, and
                    setting up visits and seminars for the Chair
                    incumbent. Professor Niebauer, a physical
                    oceanographer from the University of Alaska, was
                    the Chair incumbent during FY85. He had a
                    productive year providing seminars and lectures,
                    writing papers, and attending conferences. He
                    attended several planning sessions as a
                    participant in the forthcoming Winter MIZEX
                    experiment. Prof. Niebauer's work in
                    ice-ocean-atmospheric modeling has wide-ranging
                    applicability including the response of
                    biological processes to these forcing functions
                    in the MIZ.

Publications: None by Bourke, those by Niebauer reported
                    separately.

Conference
Presentations: None by Bourke, those by Niebauer reported
                    separately.

Theses Directed: W.A. Wilson, "Interannual Variations in the Sea
                    Ice in the East Greenland Sea," Master's thesis,
                    in progress.
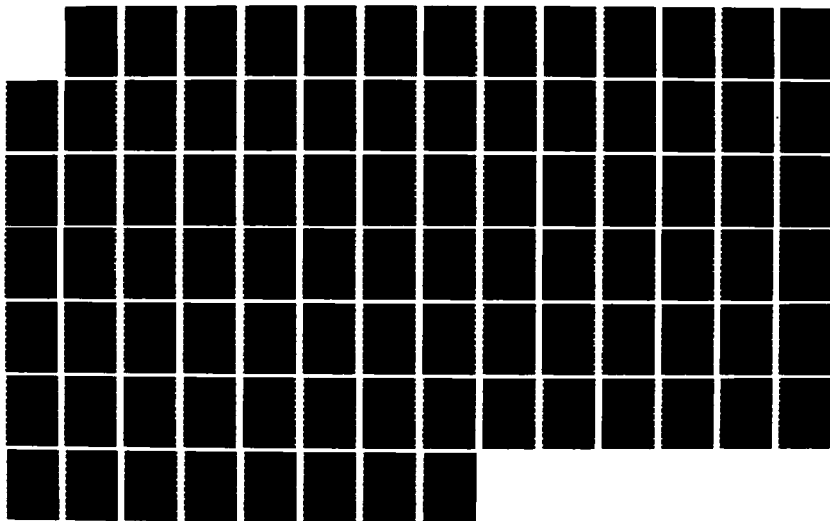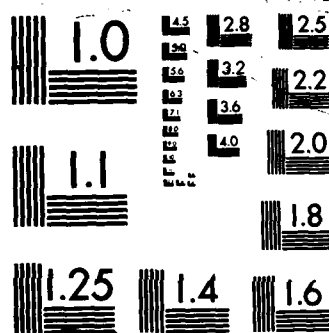
MICROCOPY RESOLUTION TEST CHART

Title:	Marginal Sea-Ice Zone Studies 1985
Investigators:	R.H. Bourke, Associate Prof. of Oceanography
	R.G. Paquette, Professor of Oceanography
Sponsor:	Arctic Submarine Laboratory
Objective:	Carry out physical oceanographic research, including field measurements, in the marginal sea-ice zone of the Bering, Chukchi, and Greenland Seas. This work has the long-term applied objective of facilitating the operation of submarines under ice. It is part of the continuing MIZPAC and MIZLANT programs.
Summary:	This is an ongoing program to study the frontal and finestructure phenomena associated with the ice edges of the Atlantic and Pacific Oceans. Measurements, primarily CTD lowerings, have been carried out from ice breakers since 1971 and include observations both in summer and winter. During FY85 we completed the data report for the 1981 cruise to the East Greenland Polar Front (EGPF) and completed a paper which discussed the oceanography of this region based on the 1981 cruise. We completed the editing and analysis of the data for the 1984 cruise to the EGPF. We perpared for and carried out a cruise to Fram Strait between 79° and 82° N during September 1985. This cruise was designed to map the westward turning of the West Spitzbergen Current and to characterize the Polar Water mass as it issues from the Arctic Ocean. As in the past, a student accompanied us on the cruise and will report his work in a Master's thesis.
Publications:	R.G. Paquette, R.H. Bourke, J.L. Newton, and W.F. Perdue, "The East Greenland Polar Front in Autumn," Journal of Geophysical Research, 90 (C3): 4866-4882, 1985.
	R.H. Bourke, M.D. Tunnicliffe, J.L. Newton, and R.G. Paquette, "Another Look at the Molloy Deep Eddy," In press.

Publications
(Cont'd):   R.H. Bourke, M.D. Tunnicliffe, J.L. Newton, and
                         R.G. Paquette, "Hydrography and Circulation Over
                         the East Greenland Continental Shelf," In press.

                         R.H. Bourke, "Preliminary Results of the
                         Oceanographic Cruise of USCGC NORTHWIND to the
                         Greeland Sea, August-September 1984," Naval
                         Postgraduate School Technical Report, NPS
                         68-84-019 December 1984.

                         R.G. Paquette, R.H. Bourke, J.L. Newton, and
                         W.F. Perdue, "The East Greenland Polar Front in
                         Autumn," Naval Postgraduate School Technical
                         Report, NPS 68-85-021, June 1985.

                         R.H. Bourke and R.G. Paquette, "MIZLANT 84 Data
                         Report, Results of an Oceanographic Cruise to
                         the Greenland Sea, August-September 1984," Naval
                         Postgraduate School Technical Report,
                         NPS 68-85-018, June 1985.

                         R.H. Bourke, and R.G. Paquette, "MIZLANT 81 Data
                         Report, Results of an Oceanographic Cruise to
                         the Greenalnd Sea, October-November 1981," Naval
                         Postgraduate School Technical Report,
                         NPS-68-85-020, August 1985.

Conference
Presentations: R.H. Bourke, R.G. Paquette, J.L. Newton, and
                         M.D. Tunnicliffe, "Oceanographic Observations on
                         the Ice-Covered Greenland Shelf," Fall Annual
                         Meeting American Geophysical Union, San Francisco,
                         December 3-7, 1984.

Theses Directed: M.D. Tunnicliffe, "An Investigation of the
                         Waters of the East Greenland Current," Master's
                         thesis, Naval Postgraduate School, Monterey,
                         September 1985. Also issued as NPS Tech. Rpt.
                         NPS 68-85-025.

                         G.E. Betts, "A Comparison Compilation of
                         Northwestern Greenland Sea Bathymetry," Master's
                         thesis, Naval Postgraduate School, Monterey,
                         September 1985. Also issued as NPS Technical
                         Report NPS 68-85-024.

                         W.T. Sleichter, "Modeling Acoustic Propagation
                         Across the East Greenland Polar Front," Master's
                         thesis, Naval Postgraduate School, Monterey,
                         December 1984. Also issued as NPS Technical
                         Report NPS 68-84-018.

Title: Studies in Support of NSWC, 1984

Investigators: R.H. Bourke, Associate Professor of Oceanography
C.R. Dunlap, Adjunct Research Professor

Sponsor: Naval Surface Weapons Center (NSWC)

Objectives: To assist in thesis research on topics of interest
to NPS and NSWC

Summary: NSWC has established an experience tour program
for NPS Air-Ocean Sciences students to spend
6 to 12 weeks at NSWC and other locations
conducting research of mutual benefit to NPS and
NSWC. During 1985 LCDR Garrett completed his
study of the seasonal and spatial variablility
of Arctic sea ice thickness, including pressure
ridging and lead statistics, based on submarine
underice sonar profiles. LT Czuba commenced an
investigation of Arctic Ocean ambient noise,
primarily in the weapons frequency range. Her
work will attempt to establish a prediction
capability between the noise sources and noise
level.

Conference
Presentations: R.P. Garrett and R.H. Bourke, "Spatial
Distributions of Arctic Sea Ice," 24th Mine
Development Conference, Washington, DC,
May 14-16, 1985.

R.P. Garrett, "Temporal and Spatial
Distributions of Arctic Sea Ice Thickness and
Pressure Ridging Statistics," Master's thesis,
Naval Postgraduate School, Monterey, March 1985.
Also issued as NPS Tech. Rpt., NPS 68-85-009.

Title: Environmental Acoustic Effects on Vertical Line Array
(VLA) Sonobuoys and the ANODE Meter

Investigators: C.R. Dunlap, Principal Investigator, Adjunct Research
Professor and R.H. Bourke, Co-Principal Investigator,
Department of Oceanography

Sponsor: Anti-Submarine Warfare Systems Project Office/Naval
Air Systems Command (PMA 264)

Objective: To gain a better technical understanding of VLA
performance, operational utilization and a measure of
confidence in associated environmental acoustic
support aids. To develop and analyze a VLA data
base. To understand the role of a sloping ocean
bottom on VLA and the ANODE meter. To compare
results from standard performance predictions and
related environmental acoustic measurement techniques
to observed results and to establish quantitative
measures of confidence.

Summary: This year emphasis has been on the deployment of a
VLA sonobuoy range off Monterey and the establishment
of telemetry, recording, and analysis techniques for
VLA measurements. Seven at-sea cruises were
conducted and an initial 15 mile acoustic range in
deep water over a sloping bottom was constructed.
Towed projector (J-15) procedures and telemetry to
about 30 miles offshore were established. SNR
measurements were made from a variety of sonobuoys
and "prototatics" for VLA near a sloping ocean bottom
were developed in association with the
training/tactics officers of VP-19 at Moffett NAS.
The Naval Air Development Center has also
participated in the project this year.

Thesis Directed: N.D. Clifford, "VLAD Performance over a Sloping Ocean
Bottom", Master's Thesis, September 1985.

293

Title: Environmental Acoustic Studies of Acoustic Signal
                          Transmission in the Wavenumber Domain

Investigators: C.R. Dunlap, Principal Investigator, Adjunct
                          Professor, Department of Oceanography, A.B. Coppens,
                          Co-Principal Investigator, Professor, Department of
                          Physics

Sponsor: Naval Ocean Research and Development Activity (Code
                          201)

Objective: To gain a better technical understanding of the
                          Wavenumber Technique (WT), which is relatively a new
                          method of underwater sound transmission analysis.

Summary: The Wavenumber Technique was used to determine the
                          depth of a point source in an isospeed ocean
                          environment. A Fourier Transform of the acoustic
                          pressure field in the range domain results in the
                          attainment of an acoustic pressure spectrum in the
                          wavenumber domain and a characteristic nodal spacing
                          unique to the source-receiver depths. Quantitative
                          examination of a magnitude plot of the spectrum and
                          use of simple mathematical formulas yield the source
                          depth. The debilitative effects of narrowband noise
                          and surface roughness on the pressure spectrum were
                          examined. The pressure spectrum was recognizable in
                          noise after the pressure field in the range domain
                          had been lost in the noise field. The effect of
                          surface gravity waves on the pressure spectrum was
                          similar to that on the pressure field in the range
                          domain: the characteristic nodal spacing was
                          suppressed as the height of the surface waves
                          increased.

Thesis Directed: P.B. King, Use of the Wavenumber Technique with the
                          Lloyds Mirror for an Acoustic Doublet, Master's
                          Thesis, March 1985.

Title: Fixed Distributed Systems: Environmental Acoustics
                          and Fiber Optic Communications

Investigators: C.R. Dunlap, Adjunct Research Professor of
                          Oceanography, J. Powers, Professor of Electrical and
                          Computer Engineering, and E.C. Haderlie,
                          Distinguished Professor of Oceanography

Sponsor: Naval Electronics Systems Command

Objective: To investigate the environmental effects on fixed
                          distributed acoustic systems by study of a sample
                          system to be installed in Monterey Bay. Additional
                          study is on the use of fiber optic cables for
                          transmitting the data.

Summary: Several aspects of fiber optic applications in an
                          undersea environment were investigated.

                          Design began on an underwater digital telemetry link
                          to perform A/D conversion, Manchester encoding of the
                          data and packet transmission to shore at a 2 Mb/s
                          data rate. A microcomputer-controlled hard disk
                          provides data storage and preliminary analysis. This
                          link is currently under fabrication and debugging.

                          A fiber optic telemetry unit used to monitor the
                          operating voltage of a long-life seawater battery was
                          designed and successfully tested in the laboratory.
                          The unit performs a v-to-f conversion, transmits the
                          optical data through the fiber, receives the data and
                          performs a f-to-v reconversion, producing a replica
                          of the battery voltage at the onshore location.

                          Mechanical testing of a fiber optic tether was
                          performed in an at-sea environment to analyze the
                          mechanical stresses in the fiber and to explore
                          techniques to decouple the platform motion from the
                          fiber tether.

                          Over-the-shore fiber optic deployment techniques were
                          evaluated in three test deployments of fiber cables
                          through the surf zone. Deployment techniques were
                          refined in successive deployments. Survival of the
                          light weight fiber cables was shown to be an issue
                          due to the short amount of time that the cable could
                          withstand the surf.

Theses Directed: LT S. King, "Feasibility Demonstration of An Ariadne
                    Fiber Optic Tether", Master's Thesis, March 1985.

                    LT A.D. Richardson, "Long Range Submarine Fiber Optic
                    Data Link", Master's Thesis, March 1985.

Title: Ocean Shallow Sound Channel Effects in the FACT 9H
                  Acoustic Transmission Loss Model

Investigators: C.R. Dunlap, Principal Investigator, Adjunct
                  Professor, Department of Oceanography, S.W. Yoon,
                  Co-Principal Investigator, Adjunct Professor,
                  Department of Physics

Sponsor: Space and Naval Warfare Systems Command

Objective: To investigate the acoustic and oceanographic
                  characteristics of shallow sound channels in deep
                  water of the North Pacific and to see how the Fast
                  Asymptotic Coherent Transmission (FACT) 9H model
                  treats the shallow sound channels.

Publications: S.W. Yoon, C.R. Dunlap and W.L. Bradfield-Smith
                  "Preliminary Investigation of Optimum Frequency for
                  Sound Propagation in Shallow Sound Channels". NPS
                  Technical Report 68-85-22, August 1985 (in press).

Thesis Directed: W.L. Bradfield-Smith, "Optimum Frequency for
                  Propagation of Sound in Shallow Sound Channels",
                  Master's Thesis, March 1985.

297

Title: Oceansystem Performance Assessment and Acoustic Array
Characteristics

Investigators: C.R. Dunlap, Principal Investigator, Adjunct
Professor, G.H. Jung, Co-Principal Investigator,
Emeritus Professor, R.H. Bourke, Co-Prinicpal
Investigator, Associate Professor, all Department of
Oceanography, T.F. Clark, Co-Principal Investigator,
AT&T Technologies, Inc.

Sponsor: COMNAVELEXSYSCOM (PDE 124-60)

Objective: To analyze the effect of environmental and acoustic
phenomena on Integrated Undersea Surveillance Systems
(IUSS) detection capability. To utilize selected
cases where operational and research data are
available for this analysis. To assess temporal and
spatial noise patterns and their effect on
operational performance.

Summary: As a part of a several year study the environmental
acoustics of the Bering and Norwegian Seas was
studied. Ocean thermal structure was assessed using
NOAA satellite and other observed environmental
acoustic data. ASEPS environmental acoustic modeling
was used with a variety of ambient noise submodels
and observed data. Errors of up to 15 db were
discovered in the DANES ambient noise model due to
errors in the Historical Temporal Shipping (HITS)
data. Two additional data collection efforts were
conducted in the Eastern Pacific as a part of the
project (i.e., FLEETEX 85 and PROPEX 85).

Publications: C.R. Dunlap and D.F. Leipper, "A Bering Sea Forecast
from Oceanographic Monthly Summary (OMS) Data".
Oceanographic Monthly Summary Vol. V, No. 3, March
1985 NOAA UNCLASSIFIED DOCUMENT.

R.F. Schwab and C.R. Dunlap, "Seasonal Acoustic
Surveillance Performance in the Bering Sea". NPS
Technical Report 68-85-010 March 1985. SECRET NOFORN

Conference
Presentation: C.R. Dunlap, G.H. Jung, and D.F. Leipper, "Depiction
of Year to Year Changes in Bering Sea Surface
Temperatures". AGU Fall Annual Meeting, San
Francisco, December 3-7, 1984.

Title: Upper Ocean Acoustic Effects

Investigator: C.R. Dunlap, Principal Investigator, Adjunct
                    Professor, Glenn H. Jung, Co-Principal Investigator,
                    Emeritus Professor, Robert H. Bourke, Co-Principal
                    Investigator Associate Professor, all Department of
                    Oceanography

Sponsor: Space and Naval Warfare Systems Command (SPAWAR6124)

Objective: To improve the technical understanding of relations
                    between sea surface roughness data and generation of
                    surveillance-related ambient noise. To design a
                    drifting buoy system to permit synotic measurements
                    of the ambient noise field concurrently with
                    environmental surface roughness data.

Summary: In preparation for the eventual testing of a drifting
                    environmental acoustic buoy, the ambient noise in an
                    area off the Monterey, California coast was measured
                    using two analysis methods. Narrow band processing
                    (9 Hz) was compared to 1/3 octave band processing for
                    frequencies up to 2500 Hz. Noise generation due to
                    shipping and local wind was examined for the
                    contribution of each to the noise spectrum. Noise
                    spectrum levels measured using either approach agreed
                    within 2 dB, usually within 1 dB. Local and distant
                    shipping varied on a daily basis and appeared to
                    coincide with port activity. The mean variability at
                    50 Hz was 5 dB for hourly records influenced by
                    individual ships. Distant shipping at 50 Hz showed a
                    2-3 dB variation. Also this study shows that mean
                    ambient noise curves may be used to estimate wind
                    speed using the ambient noise at 1700 Hz, provided
                    there are no local ships within 16 km. Ships at
                    greater range appear to contribute little to the
                    wind-dependent spectrum at 1700 Hz.

Publications: R.M. Lovelace, C.R. Dunlap and R.H. Bourke,
                    Comparison of Narrow-Band and One-Third Octave
                    Ambient Noise Measurements, NPS Technical Report, NPS
                    68-85-019, June 1985. UNCLASSIFIED DOCUMENT

Conference
Presentations: C.R. Dunlap, "Upper Ocean Acoustic Effects", Applied
Ocean Acoustics Program Review, Naval Ocean Systems
Center, San Diego, November 28-29, 1984.

C.R. Dunlap, "NPS-EARG Drifting Buoy Studies ONR
Drifting WOTAN Workshop", National Center for
Atmospheric Research, Boulder, Colorado, March 13-14,
1985.

C.R. Dunlap and K. Anderson, "EARG Drifting Buoy
Program", Arctic Buoy Conference, Fleet Numerical
Oceanography Center, Monterey, May 30-31, 1985.

Thesis Directed: R.M. Lovelace, A Comparison of Narrow-Band and
One-Third Octave Ambient Noise Measurements, M.S.
Degree, June 1985. UNCLASSIFIED DOCUMENT

Title:	Studies of the Oceanic Planetary Boundary Layer
Investigator:	R.W. Garwood, Jr., Associate Professor of Oceanography
Sponsor:	Office of Naval Research

Objective: The long range scientific objective of this research is to understand the role of the oceanic planetary boundary layer (OPBL) in the distribution of energy, momentum and mass in the upper ocean in response to atmospheric forcing.

Summary: Mathematical models of entrainment and ocean mixing are developed and verified by comparison of numerical simulations with oceanic observations for such processes as the unsteady response of the mixed layer to changing atmospheric forcing and the response of upper ocean density fronts to local atmospheric forcing. Other processes involving application of turbulence closure modeling include: i) an investigation of the role of planetary rotation upon entrainment in deep mixed layers; ii) the use of nutrient data as a chemical tracer of mixed layer dynamics; iii) the nature and importance of coupling and feedback between the OPBL and the marine atmospheric boundary layer (MABL); iv) the interaction between interior motion and boundary layer processes; and v) the use of remote sensing to determine air-sea interactions.

Publications: K.L. Davidson and R.W. Garwood, Jr., "Coupled oceanic and atmospheric mixed layer model". Dynamics of Atmospheres and Oceans, 8, pp. 283-296, 1984.

D. Adamec and R.W. Garwood, Jr., "The simulated response of an upper ocean density front to local atmospheric forcing". Journal of Geophys. Research, 90, pp. 917-928, January 1985.

P. Mueller, R.W. Garwood, Jr. and J.P. Garner, "Effect of verical advection on the dynamics of the oceanic surface mixed layer". Annales Geophys., 2, pp. 387-398, 1984.

301

R.W. Garwood, Jr., P. Muller and P.C. Gallacher, "A Model for the Equilibrium Mixed-Layer Depth in the Equatorial Pacific," Tropical Ocean-Atmosphere Newsletter, Number 30, pp. 10-11, March 1985.

R.W. Garwood, Jr., P.C. Gallacher, and P. Muller, "Wind Direction and Equilibrium Mixed Layer Depth: General Theory, "Journal of Physical Oceanography, 15, pp. 1326-1331, October 1985.

Publications
(cont'd):

E.D. Traganza, D.G. Redalje and R.W. Garwood Jr., "Nutrient Flux and Upwelling Fronts in the California Coastal Zone," in preparation.

Conference
Presentations:

P.C. Gallacher, R.W. Garwood, Jr., and P. Muller, "Wind Direction and Equilibrium Mixed Layer Depth: General Theory, "IAMAP/IAPSO Joint Assembly, Honolulu, Hawaii, August 1985.

G.D. Traganza, D.G. Redalje, M. Began and R.W. Garwood Jr., "Dynamics and Chemistry of Chlorophyll Blooms at Upwelling Fronts," AGU Fall Annual Meeting, San Francisco, December 1984.

J.W. Swaykos, K.L. Davidson, P.A. Boyle and R.W. Garwood, Jr., "Mixed Layer Results from MILDEX," AGU Fall Annual Meeting, December 1984.

Theses Directed:

E.J. Coolbaugh, "Utilization of the SEASAT Scatterometer Winds for Ocean Mixed Layer Modeling," Master's Thesis, December 1984.

B.J. Jaramillo, "One Dimensional Model Hindcasts of Warm Anomalies in the North Pacific Ocean," Master's Thesis, December 1984.

J.W. Swaykos, "Simulation of the Coupled Atmospheric and Oceanic Boundary Layer During MILDEX," Master's Thesis, December 1984.

J.J. McManus, "Coupled Mixed Layer-Acoustic Model," Master's Thesis, September 1985.

Title: The Tropical Oceanic Boundary Layer

Investigator: R.W. Garwood, Jr., Associate Professor of
                          Oceanography

Sponsor: NPS Foundation Research Program

Objective: The objective of this project is to understand the
                          role of the mixed layer in the dynamics of the
                          tropical ocean. The main thrusts of this research
                          are to develop (i) a numerical model and, (ii)
                          climatological data base for model initialization and
                          verification.

Summary: An oceanic model for tropical application has been
                          developed to include the interaction of planetary
                          rotation and Reynolds stress, and the
                          thermodynamic/hydrodynamic effects of the absorption
                          of solar radiation which penetrates the ocean
                          surface. The steady-state version of this model has
                          been tested in the equatorial Pacific Ocean, and
                          should be an important contribution to the
                          understanding of the role of turbulent mixing in the
                          distribution of properties in the equatorial oceans.
                          It has already explained the zonally asymmetrical
                          distribution of mixed layer depth in the equatorial
                          Pacific Ocean.

                          A data base for the climatological atmospheric
                          forcing for the Atlantic Ocean has been assembled,
                          enabling a test of the model in the tropical
                          Atlantic. This test demonstrated the potential for
                          the interaction of planetary rotation and Reynolds
                          stresses to mediate the climatological mixed layer
                          depth in the tropical Atlantic Ocean.

Publications: R.W. Garwood, Jr., P. Muller and P.C. Gallacher, "A
                          Model for the Equilibrium Mixed-Layer Depth in the
                          Equatorial Pacific," Tropical Ocean-Atmosphere
                          Newsletter, Number 30, pp. 10-11, March 1985.

                          R.W. Garwood, Jr., P. Muller, and P.C. Gallacher,
                          "Wind Direction and Equilibrium Mixed Layer Depth in
                          the Tropical Pacific Ocean," Journal of Physical
                          Oceanography, 15, pp. 1332-1338, October 1985.

Publications   R.W. Garwood, Jr., and P. Muller, "Modelling of the
(cont'd):   Equatorial Mixed Layer," submitted to <u>Oceanological</u>
                       <u>Data</u>, 9 pp., 1985.

Conference   P.C. Gallacher, R.W. Garwood, Jr., and P. Muller,
Presentation: "Wind Direction and Equilibrium Mixed Layer Depth:
                       General Theory," IAMAP/IAPSO Joint Assembly,
                       Honolulu, Hawaii, August 1985.

Thesis Directed: J.F.F.A. Gaspar, "The Equilibrium Mixed Layer Depth
                       in the Tropical Atlantic: The Rotation Stress and
                       Penetration of Radiation Effects," <u>Master's</u> Thesis,
                       June 1985.

Title: Biology of Stone and Wood Boring Animals in
                    Monterey Submarine Canyon and the Deeper Waters
                    off the Central California Coast

Investigator: E.C. Haderlie, Professor of Oceanography

Sponsor: ONR, Ocean Sciences and Technology Division

Objective: To determine the vertical and horizontal
                    distribution of stone and wood boring marine
                    organisms of the deeper waters of Monterey Bay
                    and to determine rates of growth and distructive
                    activies of the organisms in wood, stone,
                    concrete, and plastic. Attempt to learn the
                    specific mechanisms used in boring into hard
                    substrate.

Summary: This past year has seen the conculsion of this
                    10 year project supported by ONR.
                    Distributional studies have been completed, and
                    physiological studies have continued to
                    elucidate boring mechanics. These latter
                    studies will now be continued at Woods Hole
                    Oceanographic Institute with live animals
                    shipped from Monterey.

Publications: E.C. Haderlie, Possible Mechanisms used by
                    Marine Biulates in Penetrating Hard Siliceous
                    Stone. Proceedings of the 6th International
                    Congress on Marine Corrosion and Fouling, Athens
                    (in press).

Title:	Dissipation of Kinetic Energy in a Warm-Core Ring
Investigators:	R.G. Lueck, Adjunct Research Professor of Oceanography and T.R. Osborn, Professor of Oceanography
Sponsor:	National Science Foundation
Objective:	To survey turbulence in a Warm-Core Ring in conjunction with the intensive hydrographical, satellite, biological and chemical measurements by other investigators.
Summary:	Anomaloulsy large rates of dissipation were observed in the edge region and the thermocline of Warm-Core Rings. Large dissipation in the thermocline can be explained by inertial wave trapping by the negative vorticity of rings. Edge region dissipation appears to be associated with high frequency internal waves and intrusive shear.
Publication(s):	R.G. Lueck and T.R. Osborn, "Dissipation of Turbulent Kinetic Energy in a Warm-Core Ring", Journal of Geophysical Research, forthcoming.
	R.W. Scmitt, R.G. Lueck and T.M. Joyce, "Fine and Microstructure at the edge of a Warm-Core Ring", Journal of Geophysical Research, forthcoming.
	E. Kunze and R.G. Lueck, "Velocity Profiles in a Warm-Core Ring", Journal of Physical Oceanography, forthcoming.

Title: Towed Body Development

Investigators: R.G. Lueck, Adjunct Research Professor of
                    Oceanography and T.R. Osborn, Professor of
                    Oceanograpy

Sponsor: Naval Ocean Research and Development Activity

Objective: To develop a subsurface vehicle that can be towed
                    behind a surface ship suitable for high frequency,
                    high wavenumber observations of oceanic velocity and
                    temperature turbulence.

Summary: A survey of existing towed body types was made and a
                    twin-hulled vehicle used by the Applied Physics
                    Laboratory of the Johns Hopkins University was
                    acquired. This body was converted into a uni-hulled
                    vehicle and undesirable body motions were reduced by
                    1) making the body almost neutrally buoyant, 2) using
                    a nearly horizontal tow line, and 3) bungie cords on
                    the tow line just ahead of the body. Vibrations were
                    reduced low enough to resolve velocity turbulence in
                    the seasonal thermocline.

Publication(s):   T.R. Osborn and R.G. Lueck, "Turbulence Measurements
                    with a Towed Body", Journal of Atmospheric and
                    Oceanic Technology 2, (December 1985).

307

Title: Towed Body Microstructure Observations in Salt
                    Fingers during the C-SALT Experiment

Investigators: R.G. Lueck, Adjunct Research Professor of
                    Oceanography and T.R. Osborn, Professor of
                    Oceanography.

Sponsor: National Science Foundation

Objective: To directly measure the vertical flux of heat and
                    salt in a salt finger interface, and to measure the
                    dissipation of kinetic energy in the mixing layers
                    adjacent to salt fingers.

Summary: Experience gained with a proto-type towed body was
                    used to develop a more sophisticated vehicle able to
                    make both turbulence and hydrographic measurements.
                    The towed body was built out of a 150 gallon wing
                    tank used on A-4 jet fighters. The body was
                    completed and successfully field tested in Monterey
                    Bay in August 1985.

Title: CNOC Research Chair in MC&G and Hydrography

Investigators: C. N. K. Mooers, Professor of Oceanography and
                      J. J. von Schwind, Associate Professor of
                      Oceanography and Geodetic Sciences

Sponsor: Commander, Naval Oceanography Command

Objective: To promote the development of a progressive student/
                      faculty research program in MC&G and Hydrographic
                      Science NPS.

Summary: Prof. Narendra Saxena, Univ. of Hawaii served in the
                      Chair. He performed research on precision positioning
                      of objects on the seafloor using GPS and acoustic
                      transponders.

Theses Directed: Rahyono, "Precise Marine Positioning Using the Global
                      Positioning System". Master's Thesis. September 1985.

                      F.-Y. Kuo, "Geodetic Positioning of Ocean-Bottom
                      Benchmarks". Master's Thesis. September 1985.

Title: CNOC Research Chair in Oceanography

Investigator: C. N. K. Mooers, Professor of Oceanography

Sposor: Commander, Naval Oceanography Command

Objective: To promote the development of numerical ocean
                prediction, and to increase the interactions
                of the Oceanography Department with the Fleet
                Numerical Oceanography Center.

Summary: Professors Dale B. Haidvogel, National Center
                for Atmospheric Research, and Dong -Ping Wang,
                SUNY (Stony Brook) served in the Chair.
                Prof. Haidvogel developed a numerical model for
                coastal ocean circulation, which can be applied to
                the California coastal regime. He also developed
                and taught an advanced graduate course in numerical
                ocean circulation modeling. Prof. Wang developed
                numerical models for frontal and plume dynamics.
                He also provided a series of seminars on his research.

Title:	Eddies in the California Current System
Investigator:	C. N. K. Mooers, Professor of Oceanography
Sponsor:	Office of Naval Research
Objective:	To determine the scientific requirements for practical forecasting of mesoscale ocean variability (eddies, fronts, and jets), and to increase our quantitative understanding of the kinematics, dynamics, and energetics of the eddies, fronts, and jets in the California Current System.

Summary: A series of real-time ocean forecasting experiments are being carried out off Northern California as part of the OPTOMA Program. The OPTOMA (Ocean Prediction Through Observation, Modeling, and Analysis) Program is a joint NPS/Harvard Project. The elements of the ocean descriptive/predictive system employed include an observing system and statistical and dynamical models. The observing system includes in situ measurements of the oceanic mass field in the upper ocean made from R/V ACANIA, R/V DE STEIGUER, R/V MCARTHUR, and P-3s, and satellite remote sensing of sea surface temperature patterns using IR imagery. The instantaneous California Current System has been determined to consist of turbulent jets meandering between counter-rotating synoptic/mesoscale eddies of ca. 100 km diameter. Frequently the jets entrain coastal waters, producing cool anomalies at and near the sea surface, with strong fronts along their boundaries. In addition to a series of exploratory and statistical/kinematical field studies, prototype prediction experiments were conducted in the summers of 1983 and 1984. Two highly successful consecutive two-week forecasts were achieved during the month-long experiments in 1983. In 1984, forecasts were made and verified over a two-month period, again with appreciable success though the regime was in a different state. Further prediction experiments are planned over the next several years.

Publications: C. N. K. Mooers, A. R. Robinson, Turbulent Jets and Eddies in the California Current and Inferred Cross-Shore Transports, Science, 223:51-53, 1984.

Publications   A. R. Robinson, J. A. Carton, C. N. K. Mooers,
Continued: L. J. Walstad, E. F. Carter, M. M. Rienecker,
                      J. A. Smith, and W. G. Leslie, A Real-Time Dynamical
                      Forecast of Ocean Synoptic/Mesoscale Eddies,
                      Nature, 309: 781-783, 1984.

                      M. M. Rienecker, C. N. K. Mooers, D. E. Hagan, and
                      A. R. Robinson, A Cool Anomaly Off Northern California:
                      An Investigation Using IR Imagery and In Situ Data,
                      Journal of Geophysical Research, 90:4807-4818, 1985.

                      J. A. Smith, C. N. K. Mooers, and A. R. Robinson,
                      Estimation of Quasi-Geostrophic Modal Amplitudes
                      from XBT/CTD Survey Data, Journal of Atmospheric
                      and Oceanic Technology, 2:491-507, 1985.

                      M.M. Rienecker, and C.N.K. Mooers, "The 1982-83
                      El Nino Signal Off Northern California", Journal of
                      Geophysical Research, (to appear).

                      A.R. Robinson, J. A. Carton, N. Pinardi, and C.N.K.
                      Mooers, "Dynamical Forecasting and Dynamical
                      Interpolation in the California Current", Journal of
                      Physical Oceanography, (resubmitted).

312

Title: Optical Variability in NE Pacific Water Masses

Investigator: J.L. Mueller, Adjunct Prof. of Oceanography

Sponsor: Office of Naval Research

Objective: To characterize jointly the horizontal structure and
                     scales of optical, biological, chemical and physical
                     properties of near surface water masses in the NE
                     Pacific Ocean between 30 and 37 N latitude.

Summary: This study combines descriptive, dynamical and
                     statistical analyses of Nimbus-7 Coastal Zone Color
                     Scanner (CZCS) bio-optical images, and in situ
                     observations of optical, biological, chemical and
                     physical water mass properties. In situ data were
                     obtained in prior years and in the present reporting
                     period on two R/V ACANIA cruises in October 1983 and
                     April 1984. An ensemble of CZCS images is being
                     analysed using partioned empirical orthogonal
                     function methods, and through comparison with
                     associated variability in optical, biological and
                     physical oceanographic profiles along cross shelf
                     sections.

Publication(s):   J.L. Mueller, 1985. Nimbus-7 CZCS: confirmation of
                     its radiometric decay rate through 1982. Applied
                     Optics, 24:1043.

                     Other manuscripts in preparation.

Title: Overview of NROSS Ground Data Processing Technical
                    Requirements

Investigator: J.L. Mueller, Adjunct Prof. of Oceanography

Sponsor: Naval Environmental Prediction Facility (NEPRF)

Objective: To provide NEPRF with a technical overview of the
                    algorithm structure and software development
                    requirements for ground processing of data from the
                    remote sensing systems planned for flight on the Naal
                    Remote Ocean Sensing Satellite (NROSS).

Summary: Using algorithm "freeze reports" produced for the
                    National Oceanic Satellite System (NOSS), preliminary
                    "strawman" narrative algorithms descriptions, sensor
                    data set descriptions, and Hierarchial
                    Input-Process-Output descriptions were prepared for
                    the NROSS instruments. These documents were
                    provided, through NEPRF, to the NRL algorithm
                    development teams as a starting point for defining
                    and documenting the algorithms for each sensor in a
                    format and structure suitable for efficient software
                    design (by NEPRF). This material constituted the
                    only deliverable required for this project.

314

Title: Ocean Microstructure

Investigators: T.R. Osborn, Professor of Oceanograpy and R.G. Lueck,
                    Adjunct Research Professor of Oceanography.

Sponsor: Office of Naval Research

Objective: To measure and characterize oceanic turbulence and to
                    determine the role of turbulence in large scale
                    circulation and the vertical flux of heat, salt, and
                    momentum.

Summary: Successful measurements of turbulence, large scale
                    shear, acoustic scattering and phytoplankton sampling
                    were made in the seasonal thermocline of Monterey Bay
                    from the research submarine USS DOLPHIN. Data from
                    the vertical profiler CAMEL II, taken off San Diego
                    in conjunction with the USS DOLPHIN and data taken in
                    the mixed layer during the MILDEX Experiment are
                    being analyzed.

Publication(s):   T.R. Osborn and R.G. Lueck, "Turbulence Measurements
                    with a Submarine", Journal of Physical Oceanography,
                    15, (1985), pp. 1502-1520.

                    R.G. Lueck and T.R. Osborn, "Turbulence in a
                    Submarine Canyon", Continental Shelf Research 4, pp.
                    681-698.

                    T.R. Osborn and R.G. Lueck, "Turbulence and
                    Hydrographic Measurements from the USS DOLPHIN (AGSS
                    555) in April, 1982", Naval Postgraduate School,
                    Manuscript Report, 1985.

                    T.R. Osborn and R.G. Lueck, "Oceanic Shear Spectra
                    from a Submarine", Proceedings of the Hawaiian Winter
                    Workshop on Internal Gravity Waves and Small-Scale
                    Turbulence January 1984, Muller and Pujalet,
                    editors, (1984).

                    T.R. Osborn, R.G. Lueck and T.C. Sullivan, "Diapycnal
                    Mixing in the Central Gyre", Proceedings of the
                    Hawaiian Winter Workshop, University of Hawaii at
                    Manoa, January 1985, (1985).

Title:	Density, Shear and Turbulence Measurements in the Upper Ocean
Investigators:	E.B. Thornton, Professor of Oceanography and T.P. Stanton, Adjunct Research Professor in Oceanography
Sponsor:	Office of Naval Research, Physical Oceanography Program
Objective:	Upper ocean profile measurements of density, velocity and acoustic backscatter were made in the vicinity of FLIP during MILDEX in October 1983. These measurements will be used to define vertical and horizontal scales of the upper ocean structure advecting relative to FLIP. Secondly, measurements of shear using a free-falling acoustic doppler profiler and airfoil probes will be used to determine shear scales throughout the water column. Thirdly, the feasibility of measuring turbulence induced by the straining of the wave field in the nearsurface by the mean shear flow is to be determined; measurement of surface elevation, velocity shear and shear microstructure near the surface will be made from the RS DOLPHIN.

Summary:	Analysis is proceeding on data collected during a ten day, 5 km box-section time series of current and C/T profiles measured at the MILDEX site in October 1983. The observed changes in the mixed layer are to be modeled in terms of both the measured atmospheric forcing and the internal wave field, and the directly measured stability of the water column spanning the mixed layer. Collaborative experiments with Profs. Tom Osborn and Rolf Lueck using the R/V DOLPHIN were conducted in April and October 1984 measuring high resolution shear, C/T and dissipation profiles. Current Profile measurements from a 1.2 MHZ doppler profiler are used to measure 1 m-30 m vertical shear scales in close proximity to velocity and temperature microstructure probes in order to determine the horizontal and vertical extent of high dissipation regions in the upper ocean.

Title: Nearshore Wave Properties

Investigator: E.B. Thornton, Professor of Oceanography

Sponsor: Office of Naval Research

Objective: Basic studies are being made on the kinematics of
                        breaking waves within the surf zone in the field.
                        The specific objectives of the proposed research are:
                        (1) determine breaking criterion as a function of
                        depth, beach slope and wave frequency and (2)
                        determine the transformation of waves and longshore
                        currents across the surf zone due to energy
                        conversion and dissipation in the breaking process.

Summary: Research this past year emphasized the continued
                        analysis of the results of the major field
                        experiments at Torrey Pines, California and Santa
                        Barbara, California, and the development of
                        predictive models. A model describing the
                        transformation of random wave heights and resulting
                        longshore currents was developed based on energy flux
                        balance. Dissipation is considered due to wave
                        breaking and bed friction. Wave breaking is
                        characterized after periodic bores. The random
                        nature of the wave heights is described starting with
                        the Rayleigh distribution in deep water. The
                        Rayleigh distribution is modified by wave breaking
                        with an empirical transfer function. The modified
                        distribution is itself the Rayleigh distribution.
                        The model is compared both with laboratory results
                        and an extensive set of field measurements collected
                        at Torrey Pines Beach, California. The model is able
                        to predict the increase in averaged wave height due
                        to shoaling and subsequent decrease due to wave
                        breaking. The model has only one adjustable
                        parameter and is able to predict rms wave heights to
                        within a standard error of 9,3% throughout the region
                        from offshore to the beach. Twenty-three M.S. theses
                        have resulted from this research program.

317

Publications:
S. Aranavachapun, and E.B. Thornton, "Spatial and Temporal Transformation of Shallow Water Wave Energy" J. Geophysical Research, 89, 6453-6465, 1984".

R.T. Guza, and E.B. Thornton, "Velocity Moments in the Nearshore," J. Waterways, Harbours and Coastal Engineering, 111, 235-256, 1985.

R.T. Guza, and E.B. Thornton, "Observations of Surf Beat" J. of Geophysical Research, 90, 3161-3172, 1985.

R.T. Guza, E.B. Thornton, and R. Holman, "Swash on Steep and Shallow Beaches", 19th International Conference on Coastal Engineering, ASCE, 708-723, 1985.

C.-S. Wu, E.B. Thornton, and R.T. Guza, "Nearshore Current Model Compared with Field Data," J. Geophysical Research, 90, 4951-4958, 1985.

E.B. Thornton, C.-S. Wu, and R.T. Guza, "Breaking Wave Design Criteria", proc. 19th Coastal Engineering Conference, ASCE, 31-41, 1985.

E.B. Thornton, and R.T. Guza, "Surf Zone Longshore Currents and Random Wave: Models and Field Data", accepted in J. Physical Oceanography.

Title: Test and Evaluation of Sea, Swell and Surf Programs
                        (SSSP)

Investigators: E.B. Thornton, Professor of Oceanography

Sponsor: Naval Environmental Prediction Research Facility

Objective: The FORTRAN code for the Sea, Swell and Surf Program
                        (SSSP) is being converged to a BASIC code to run on a
                        Hewlett-Packard 9845B-275 mini-computer. Test and
                        evaluation will be performed on the model using
                        extensive available wave and surf data from La Jolla,
                        CA, Santa Barbara, CA, and Duck, North Carolina.
                        These field experiments cover a wide variety of wave
                        and surf conditions.

Summary: A sea, swell, and surf program was improved, tested,
                        and evaluated on a micro-computer (HP-9845B). Sea
                        swell is calculated by a two dimensional spectral
                        model. The energy balance equation is tested for
                        different cases of wind velocities and water depths.

                        Wave transformation is described by one dimensional
                        random wave model in which the wave heights are
                        described using the Rayleigh distribution. The
                        obtained solution of the random wave field is used to
                        predict the longshore currents. The model outputs of
                        wave height and current are compared with data
                        acquired from a wave tank and natural beaches. The
                        model is found to accurately forecast wave heights,
                        breaker location, breaker type and longshore currents
                        for several sets of conditions. Two M.S. theses
                        resulted from this research.

Reports: M.T. Gill, "Sea, Swell, and Surf Program (SSP) User's
                        Guide", Report to the Naval Environmental Prediction
                        Research Facility, October 1985.

DEPARTMENT

OF

MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

The Research program in the Department of Mechanical Engineering has continued in several areas: applied mechanics; heat transfer; hydrodynamics and fluid mechanics; and materials science.

APPLIED MECHANICS

Professor Cantin has been conducting research for David W. Taylor Naval Ship Research and Development Center (DWTNSRDC) to automate the post-buckling analysis of rib reinforced shell structures and implement the resulting codes in microcomputers. So far, a VAX-based computer code for the analysis of several examples has been designed and used to prove the automatic strategy adopted. Several auxiliary codes were also written to process the final results in the form of GRAPHS. The codes were all ported to the APOLLO workstation and worked without fault. The nonlinear analysis includes pre- and post-buckling behavior for any degree of non-linearity due to large displacements and large rotations but small strains. The formulation includes some recent developments in plate and shell theories and automatic solution strategies for the non-linear equations all adapted for implementation in micro-computers with virtual memory.

Professor Nunn has continued his research on development of simulation and design codes for electromechanical actuators. This work is in support of the Naval Weapons Center, China Lake (NWC) program, "Advanced Missile Control Devices." The study was begun to model and simulate a missile fin actuation system driven by a brushless dc motor. Preliminary studies were performed on the modeling of the motor, drive-train, and load, using the usual linear descriptions. Simulation of the system response to step and frequency inputs was accomplished using the Continuous System Modeling Program. Initial qualitative results show that the model successfully predicts the effects expected from variations in load and damping. Further evaluation of the model and possible refinements will be accomplished as test data becomes available.

Professor Salinas has initiated a research project with the Naval Surface Weapons Center, Dahlgren (NSWC) to adapt the Garrett 3-D combustor code to the specific test cell geometry and flow environment of typical jet engine test cells. The modified combustor code will also be used to predict the temperature, pressure and velocity profiles within an augmentor tube. NSWC feels that it is important in the initial design,

as well as in any subsequent modifications, of test cells to be able to predict the flow environment within augmentor tubes. Past efforts have only been partially successful since they have been obtained using one or two-dimensional models. The flows are most often three-dimensional due to secondary air injection and/or the placement of pollution/noise abatement devices. These devices also affect the velocity and temperature distributions at the exit of the exhaust stack. This can have significant effects on the required positioning of pollution/measurement devices.

Professor Shin has continued his research for DWTNSRDC on developing acoustic damping measurement and modal testing of naval material at low stress level, high frequency range, and various temperatures in a water environment. The measurement techniques include the impact hammer technique and the random excitation method. Sensitivity studies were performed to evaluate how various parameters affect the damping, such as boundary conditions, size of specimen, sensor mounting method, etc.. Professor Shin has also continued his research for the Defense Nuclear Agency (DNA) on numerical and experimental studies of the underwater shock-induced responses of the submerged structures. The transient elastic-plastic responses of the submerged stiffened plate to the transverse acoustic loads were predicted, using EPSA and USA-STAGS computer codes. The tripping of stiffener and its effect to the gross shell response are the goals to achieve. Underwater explosion tests were performed and the data were correlated with the predictions.

Professor Smith has continued to investigate the application of optimal control theory to the control of robotic mechanisms. This work involved the dynamic modeling of various robot actuator and manipulator parts, and the development of test-bed computer simulation programs. An evaluation of candidate "optimal" strategies will be conducted via dynamic simulation. The most promising strategy will be implemented in a computer-based robot controller. The importance of key assumptions about nonlinear design performance will be investigated. In a related effort, Professor Smith has begun a project with NSWC aimed at developing a prototype robotic fire-fighter. The project has so far completed the system predesign and identified a series of tasks for near-term study. The tasks that were identified were: measuring the forces on a fire-fighter manipulator; hydraulic system upgrade for a candidate manipulator arm; control system synthesis for a fire-fighter arm; fire-fighter robot wrist design.

HEAT TRANSFER

Professors Nunn and Kelleher are studying jet vane vector control system heat transfer, with emphasis on vanes and tabs in supersonic flow. Experiments are being planned to verify the models.

Professor Marto, together with Adjunct Research Professor Wanniarachchi, are continuing their studies of two-phase heat transfer phenomena. Under a National Science Foundation (NSF) grant, they have determined the influence of various enhancement techniques upon steam condensation heat transfer coefficients on a single horizontal tube. With the collaboration of Dr. John W. Rose of Queen Mary College, UK, effects of fin spacing and shape have been examined. Enhancements as large as four to six times the smooth tube value have been obtained using a fin spacing of 1.5mm. Under a grant from DWTNSRDC, an experimental study has been conducted of the nucleate boiling performance of refrigerant-oil mixtures from several commercially available enhanced boiling surfaces. Heat transfer coefficients have been found to increase over smooth tube values by a factor of seven to ten, using a high heat flux surface. These enhancements decrease for oil concentrations greater than six percent. In a second study sponsored by DWTNSRDC, an extensive literature search and critique were conducted on various cooling techniques to remove heat from electrical machinery. Attention was focused on the use of water undergoing phase change in rotating heat pipes.

Professor Ligrani has begun a study on the effects of an embedded vortex on heat transfer in film cooled tubulent boundary layers. This problem is important in regard to a variety of engineering applications, especially the end-wall of the first turbine stage of gas turbine engines, where thermal loading is severe and intense secondary flows are present. The effects of vortex location, injection temperature, injection flow rate and other parameters were investigated. Professor Ligrani is continuing analytic work on the effects of variable properties in film cooled turbulent boundary layers. Attention is focused on empirical corrections, and the relation between adiabatic film cooling effectiveness, and heat transfer coefficients based on the wall and gas temperature difference.

HYDRODYNAMICS AND FLUID MECHANICS

Professor Kelleher's research efforts have been dedicated to the computation of flow over compliant surfaces. A spectral code for the analysis of two-dimensional turbulent flow over a moving wavy wall which incorporates a mixing length/eddy viscosity turbulence model, as well as a conformal mapping preprocessor to deal with the complex geometry associated with wavy walls, has been used to conduct an extensive study of the turbulent flow over a moving wall. The results of these calculations indicate that in the moderate wave speed rang (0.2 to 0.8), moderate drag reduction is obtained.

Professors Nunn and Kelleher are developing analytical models to predict the heat transfer characteristics of jet vanes immersed in a

rocket nozzle exhaust. PHOENICS systems of programs will allow the complex geometries associated with jet vanes in conical flow to be handled. The Code has been developed by and purchased from CHAM, Ltd. of London. Subsequently, verification experiments will be carried out through the use of an infrared thermal imaging video system. The heat transfer from a heated double wedge at zero angle of attack in a two-dimensional, viscous, supersonic flow will be the first problem investigated.

Professor Ligrani's research efforts are dedicated to the study of small-scale structural characteristics and eddy motions. The purchase of the equipment and the development of subminiature hot-wire sensors are in progress.

Professor Pucci is interested in the design of exhaust gas eductor design, in the development of an analytical model for gas turbine installations, and in gas turbine propulsion engine installations. The objectivs of these on-going investigations are to provide guidance in the design and operation of eductor systems for the new Arleigh Burke class destroyer and to assist the Navy in the general area of gas turbine propulsion.

Professor Sarpkaya's research efforts dealt with a number of projects. The first is the study of the evolution of trailing vortices in homogeneous and density-stratified media. A series of experiments have been carried out in a long towing tank and the rise and demise of the trailing vortices generated by various lifting surfaces have been evaluated. The predictions of a parallel theoretical investigation have yielded results in surprisingly good agreement with those obtained experimentally. The second investigation dealt with the yaw and current effects on smooth and rough cylinders in a harmonically oscillating flow. It has been shown that the effect of wake-biasing resulting from the current is very significant and the force-transfer coefficients obtained in the absence of current cannot be used to predict the forces acting on cylinders subjected to the combined flow field. Finally, Professor Sarpkaya has continued his long-range investigation on the discrete vortex simulation of separated time-dependent flows. Currently, the model is being applied to oscillating flow about a cylinder.

MATERIALS SCIENCE

Professor Challenger has continued his leave status during FY85 to serve as Liaison Scientist in the Office of Naval Research London, a position he will hold until his return to NPS in July 1986. At that time, he is expected to resume his research in the area of joining of materials.

Professor Kassner's research, funded by the NPS Foundation Research program, has centered on the fundamentals of deformation processes in FCC metals, including studies on creep and cyclic strain in FCC metals.

Professor McNelley has continued research in the area of deformation processing and elevated temperature superplastic response of high Mg, Al-Mg alloys, including Al-Mg-Li alloys, under the sponsorship of the Naval Air Systems Command. Work in this area has demonstrated that thermomechanical processing by warm rolling results in the development of refined subgrain structures in conjunction with finely dispersed precipate phases, and can lead to remarkable superplastic elongations at temperatures and strain rates that are beyond the expected limits. This project has recently acquired the association of Adjunct Research Professor Stephen Hales, a recent graduate of the University of Illinois. During FY85, Professor McNelley has also continued work on the rolling contact fatigue behavior of high carbon M-50 steel, as influenced by processing history, under sponsorship from the Air Force Wright-Patterson Aeronautical Laboratories. The most recent work has considered the role of micropores, associated with insoluble carbide particles, as crack initiation, as well as the possibility of closing the porosity by hot isostatic pressing. During FY85, Professor McNelley also carried out a critical review for the Naval Sea Systems Command of the current scientific understanding of the ignition and combustion of stainless steel and Monel.

Professor Perkins continued his research on martensitic transformation in shape memory alloys for the National Science Foundation. Over the past several years, this program has considered the effect of cyclic transformation and deformation on the shape memory behavior, primarily by an examination of microstructures by high resolution transmission electron microscopy techniques. The program has recently acquired the services of Adjunct Research Professor Ming-Hsiung Wu, a recent graduate of the University of Illinois. During FY85, work on these alloys has been extended to consider the high damping properties of these martensitic alloys, with the support of the David W. Taylor Naval Ship Research and Development Center, Annapolis.

Title: Geometrically Nonlinear Analysis of Shell Structures
                  Using Flat DKT Shell Elements

Investigators: G. Cantin, Professor of Mechanical Engineering, and
                  J.-L. Batoz, Adjunct Research Professor of Mechanical
                  Engineering

Sponsor: David W. Taylor Naval Ship Research and Development
                  Center

Objective: To automate the post-buckling analysis of rib re-in-
                  forced shell structures and implement the resulting
                  codes in microcomputers.

Summary: A VAX-based computer code for the analysis of several
                  examples was designed and used to prove the auto-
                  matic strategy adopted. Several auxiliary codes
                  were also written to process the final results in
                  the form of GRAPHS. The codes were all ported to
                  the APOLLO workstation and worked without a glitch.
                  The nonlinear analysis includes pre- and post-buck-
                  ling behavior for any degree of non-linearity due to
                  large displacements and large rotations but small
                  strains. The formulation includes some recent dev-
                  elopments of plate and shell theories, automatic
                  solution strategies for the nonlinear equations; all
                  adapted for implementation in micro-computers with
                  virtual memory.

Publication: J.-L. Batoz, and G. Cantin, "Geometrically Nonlinear
                  Analysis of Shell Structures Using Flat DKT Shell
                  Elements," Naval Postgraduate School Report, NPS
                  69-85-007PR, November 1985.

Title: Computation of the Flow over Compliant Surfaces

Investigator: M. D. Kelleher, Professor of Mechanical Engineering,
                          and R. E. Newton, Professor of Mechanical Engineering

Sponsor: Office of Naval Research

Objective: To calculate the effect of a moving wavy surface on
                          the turbulent boundary layer flow over the surface.

Summary: A spectral code for the analysis of two dimensional
                          turbulent flow over a moving wavy wall which incor-
                          porates a mixing length/eddy viscosity turbulence
                          model as well as a conformal mapping preprocessor to
                          deal with the complex geometry associated with wavy
                          walls, has been used to conduct an extensive study
                          of the turbulent flow over a moving wavy wall. Cal-
                          culations have been made on a CYBER 176 computer at
                          Fleet Numerical Oceanographic Center, Monterey, for
                          three values of wave amplitude to wave length ratio
                          (.01, .02, .03) and three values of initial boundary
                          layer thickness to wave length ratio (0.2953, 1.1811,
                          4.7244). All the calculations have been made in a
                          wave speed range of from -0.2 to 1.2 times the free
                          stream velocity. All calculations have been made
                          for the case of:

$$Re = 7300. \quad \text{(Re based on momentum}$$
$$Cf = .0028 \qquad\qquad \text{thickness)}$$

Surface pressure as well as surface shear distribu-
tions have been obtained. By integrating the stream-
wise components of these, values of pressure drag,
shear drag, and total drag have been obtained for
each flow situation calculated. The results of
these two dimensional calculations indicate that in
the moderate wave speed range (0.2 to 0.8) moderate
drag reduction is obtained.

Conference   M. D. Kelleher, "Computation of Turbulent Flow Over
Presentation: a Moving Wavy Wall," Drag Reduction and Boundary
                          Layer Control Symposium, National Academy of Sci-
                          ences, Washington, DC, October 22-25, 1985.

Title: Effect of An Embedded Vortex on Heat Transfer in
                  Film-Cooled Turbulent Boundary Layers

Investigator: P. M. Ligrani, Associate Professor of Mechanical
                  Engineering

Sponsor: Wright Aeronautical Laboratories

Objective: To study the effects of the intense secondary flows,
                  especially embedded vortices, on the cooling schemes
                  used for end-wall surfaces in the first turbine
                  stage of gas turbine engines.

Summary: A single embedded vortex, located upstream of a row
                  of film cooling holes, causes significant changes in
                  downstream heat transfer. A preliminary experiment
                  has been conducted to show this effect using liquid
                  crystals, energy balance and surface temperature
                  measurement schemes.

Title:	The Turbulent Boundary Layer: Small-Scale Structural Characteristics and Eddy Motions
Investigator:	P. M. Ligrani, Associate Professor of Mechanical Engineering
Sponsor:	NPS Foundation Research Program
Objective:	To study small-scale fluid motions in the near-wall portions of turbulent boundary layers.
Summary:	Purchase of equipment and design of new facility to allow study of near-wall turbulent motions. Study of needed type of data acquisition system. Development and analysis of subminiature hot-wire sensors with spatial resolution.
Publication:	P. M. Ligrani, "Subminiature Hot-Wire Sensor Construction," Naval Postgraduate School Technical Report, NPS69-84-010, November 1984.
Conference Presentation:	P. M. Ligrani, "Subminiature Hot-Wire Sensors and Resolution of Small-Scale Turbulence," Fifth Symposium on Turbulent Shear Flows, Cornell University, New York, August 7-9, 1985.

Title: Variable Property Effects in Film-Cooled Turbulent
                    Boundary Layers

Investigator: P. M. Ligrani, Associate Professor of Mechanical
                    Engineering

Sponsor: None

Objective: To develop empirical and analytic expressions to
                    describe the effects of variable properties on film-
                    cooled turbulent boundary layers in high temperature,
                    compressible environments.

Summary: Analysis shows that two different variable property
                    effects influence wall heat transfer in film-cooled
                    turbulent boundary layers: (1) variation of density
                    ratio and (2) variation of thermal conductivity and
                    absolute viscosity.

Title:	Enhanced Condensation of Steam on Horizontal Tubes
Investigators:	P. J. Marto, Distinguished Professor and Chairman of Mechanical Engineering and J.W. Rose and A.S. Wanniarachchi, Adjunct Research Professors of Mechanical Engineering
Sponsor:	National Science Foundation
Objective:	To experimentally determine the influence of various enhancement techniques upon steam condensation heat transfer coefficients on a single horizontal tube.

Summary: A single tube apparatus was designed and constructed to reliably measure steam condensation heat transfer coefficients. Over 60 finned tubes were tested to study the influence of fin geometry upon the film condensation heat transfer coefficient of steam. It was found that fin spacing was the most important variable. The best tube had a fin spacing of 1.5 mm. Rectangular fins with this spacing gave heat transfer coefficient enhancements of from 4 to 6 times the smooth tube value depending on steam pressure. Fin thickness and shape were found to influence the results slightly. Wall conductivity affected the results significantly. A wide variety of organic coatings have been evaluated for their steam endurance characteristics during the past two years. Several promising coatings were applied to horizontal tubes for heat transfer measurements - enhancements of from 3 to 9 times the smooth tube film condensation value were obtained.

Publications: A.S. Wanniarachchi, P.J. Marto and J.W. Rose, "Film Condensation of Steam on Horizontal Finned Tubes: Effect of Fin Spacing," Journal of Heat Transfer (Accepted for Publication 1986).

A.S. Wanniarachchi, P.J. Marto and J.W. Rose,"Film Condensation of Steam on Horizontal Finned Tubes: Effect of Fin Spacing, Thickness and Height," Multiphase Flow and Heat Transfer, ASME HTD-Vol. 47, edited by V.K. Dhir, J.C. Chen and O.C. Jones, Denver, 1985, pp. 93-99.

P.J. Marto, E. Mitrou, A.S. Wanniarachchi and J.W. Rose, "Film Condensation of Steam on Horizontal Finned Tubes: Effect of Fin Shape," 8th International Heat Transfer Conference, San Francisco, CA,(Accepted for Publication August 1986).

K.M. Holden, A.S. Wanniarachchi, P.J. Marto, D.H. Boone and J.W. Rose, "The Use of Organic Coatings to Promote Dropwise Condensation of Steam," *Journal of Heat Transfer*, (Submitted for publication).

Theses Directed: F.A. Flook, "Film Condensation of Steam on Externally Finned Horizontal Tubes," <u>Master's Thesis</u>, March 1985.

D.J. Looney, "Endurance and Heat Transfer Performance of Polymer Coatings for the Promotion of Dropwise Condensation of Steam," <u>Master's Thesis</u>, March 1985.

337

Title:	An Evaluation of Heat Transfer Concepts for Use in Electrical Machinery
Investigators:	P.J. Marto, Distinguished Professor and Chairman of Mechanical Engineering and Adjunct Research Professor A.S. Wanniarachi
Sponsor:	David W. Taylor Naval Ship Research and Development Center
Objective:	To examine various cooling schemes for use in electrical machinery and provide guidance on which schemes appear most promising for naval usage.
Summary:	An extensive literature search and critique were conducted on the various cooling techniques to remove heat from electrical machinery. An analytical comparison was made between the cooling effectiveness of water undergoing phase changes in a rotating heat pipe. The specific use of rotating heat pipe technology in cooling electric motors was studied and recommendations for future usage were made. An experiment was planned to compare a conventionally-cooled electric motor to one cooled using a rotating heat pipe in the motor shaft.
Publications:	A.S. Wanniarachchi and P.J. Marto, "An Evaluation of Liquid and Two-Phase Cooling Techniques for Use in Electrical Machinery," Report NPS69-84-013, Naval Postgraduate School, December 1984.
	P.J. Marto and A.S. Wanniarachchi, "The Influence of Internal Axial Fins on Condensation Heat Transfer in Co-axial Rotating Heat Pipes," Symposium on Transport Phenomena in Rotating Machinery, Honolulu, HI, May 1985.
Thesis Directed:	J.L. Szatkowski, "Cooling of High Power Generators and Motors for Electric Propulsion," Master's Thesis, March 1984.

Title: NAVSEA RESEARCH CHAIR

Investigator: Paul J. Marto, Distinguished Professor and Chairman,
                    Department of Mechanical Engineering

Sponsor: Naval Sea Systems Command

Objective: To conduct research of interest to NAVSEA and to
                    interact with students and faculty at NPS.

Summary: Dr. T. B. Massalski, Professor of Metal Physics
                    and Materials Science, Carnegie Mellon University,
                    occupied the NAVSEA Chair during FY85.

                    His research was focused on a study of metallic
                    materials which exhibit high damping characteristics.
                    After reviewing numerous possible alloys, attention
                    was given primarily to the so-called "shape memory"
                    alloys such as Cu-Zn-Al, Cu-Al-Ni, Ti-Ni. Small
                    samples of these materials, and others, were
                    prepared and tested using a "tapping technique" to
                    measure their damping characteristics. Results
                    showed that damping factors nearly twenty times
                    that of ordinary Al-bronze are possible. Heat
                    treatment was found to be an important process in
                    altering the damping characteristics of these
                    materials. Testing of new materials will continue.

Title: Nucleate Boiling Behavior of R114 from Structured
                    Surfaces

Investigators: P.J. Marto, Distinguished Professor and Chairman
                    of Mechanical Engineering and A.S. Wanniarachchi,
                    Adjunct Research Professor of Mechanical
                    Engineering

Sponsor: David W. Taylor Naval Ship Research and Development
                    Center

Objective: To experimentally study the nucleate boiling
                    performance of R-114 and R-114/oil mixtures from
                    several commercially available boiling surfaces.

Summary: A single tube experimental apparatus was constructed
                    to measure the nucleate pool boiling characteristics
                    of R-114 and R-114/oil mixtures. The test tube was
                    designed to be electrically heated and thermocouples
                    were utilized to measure the temperature distribu-
                    tion in the wall of the boiling surface as well as
                    in the liquid pool and the vapor space. The exter-
                    nal, nucleate pool-boiling heat transfer coefficient
                    was measured for a smooth copper tube and for a
                    copper-nickel tube on which was placed a High Flux
                    porous coating. The High Flux surface was found to
                    improve the heat transfer coefficient over the
                    smooth tube value by a factor of 7 to 10 in oil-free
                    R-114. With oil concentrations greater than six
                    percent, the boiling performance of the High Flux
                    surface was reduced considerably at heat fluxes in
                    excess of 30 kW/m^2.

Publications: A.S. Wanniarachchi, P.J. Marto and J.T. Reilly,
                    "The Effect of Oil Contamination on Nucleate Pool-
                    Boiling Performance of R-114 from a High Flux-
                    Coated Surface," ASHRAE Annual Meeting (Submitted
                    for Publication 1986).

Theses Directed   M. Karasabun, "An Experimental Apparatus to Study
                    Nucleate Pool Boiling of R-114 and Oil Mixtures,"
                    Master's Thesis, December 1984.

                    J.T. Reilly, "The Influence of Oil Contamination on
                    the Nucleate Pool-Boiling Behavior of R-114 from a
                    Structured Surface," Master's Thesis, March 1985.

Title:	High-Strength Aluminum-Magnesium Alloys: Thermo-mechanical Processing, Microstructure and Mechanical Properties
Investigator:	T. R. McNelley, Associate Professor of Materials Science
Sponsor:	Naval Air Systems Command
Objective:	To study the development by thermomechanical process-ing of microstructure in high-Mg, Al-Mg alloys, including Al-Mg-Li alloys, with particular emphasis on the influence of microstructure on the elevated temperature superplastic response of these alloys.

Summary: Thermomechanical processing by warm rolling results in the development of refined subgrain structures in conjunction with finely precipitated β_{Mg} (Al_8Mg_5) in Al-8 to 10 pct. Mg alloys. Such alloys may exhibit superplastic elongations in excess of 600 pct at temperatures as low as $300^{\circ}C$ and strain rates of 2 to $5 \times 10^{-3}5^{-1}$. Such behavior is remarkable in that wrought Al alloys generally do not exhibit such elongations unless temperatures are much higher and strain rates much lower. Of further note is the absence of cavitation in these alloys under such low temperatures, high strain rate conditions. The low-temperature superplasticity in this system is the result of continuous recrystallization during deformation; fine particles resulting from Mn, Zr or Cu additions retard growth of the recrystallized grains and thus enhance resulting superplastic elong-ations. Analysis of superplastically deformed mater-ial has demonstrated that recrystallization during deformation results in a finer structure the higher the strain rate and lower the temperature. Follow-ing simulated superplastic forming, these materials still exhibit tensile strengths up to 60 Ksi (410 MPa) with ductility ranging up to 14 pct.

Publications: T. R. McNelley, E.-W. Lee and M. E. Mills,"Super-plasticity in a Thermomechanically Processed High-Mg, Al-Mg Alloy," Metallurgical Transactions, forth-coming.

E.-W. Lee, T. R. McNelley and A. F. Stengel, "The Influence of Thermomechanical Processing Variables on Superplasticity in a High-Mg, Al-Mg Alloy," Met-allurgical Transactions, forthcoming.

341

Conference
Presentations:

T. R. McNelley and E.-W. Lee, "Effect of TMP Variables on Superplasticity in an Al-10Mg-0.5Mn Alloy," AIME Annual Meeting, New York, New York, February 24-28, 1985.

T. R. McNelley, "Superplasticity in Thermomechanically Processed High-Magnesium, Aluminum-Magnesium Alloys," Symposium on Mechanical Behavior of Aluminum Alloys, Stanford University, Stanford, CA, April 16, 1985.

Theses Directed:

A. F. Stengel, "Effects of Annealing Treatments on Superplasticity in a Thermomechanically Processed Al-10.2% Mg - 0.52% Mn Alloy," Master's Thesis, December 1984.

R. J. Self, "The Effect of Alloying Additions on Superplasticity in Thermomechanically-Processed, High-Mg Al-Mg Alloys," Master's Thesis, December 1984.

D. B. Berthold, "Effect of Temperature and Strain Rate on Microstructure of a Deformed, Superplastic Al-10% Mg-0.1% Zr Alloy," Master's Thesis, June 1985.

T. S. Hartmann, "Mechanical Characteristics of a Superplastic Aluminum - 10.2% Mg.-0.1% Zr Alloy," Master's Thesis, June 1985.

M. E. Alcamo, "Effect of Strain and Strain Rate on the Microstructure of a Superplastically Deformed Al-10% Mg-0.1% Zr Alloy," Master's Thesis, and Engineer's Thesis, June 1985.

Title:	Investigation of the Influence of Porosity on Behavior of M-50 Bearing Steel
Investigator:	T. R. McNelley, Associate Professor of Materials Science
Sponsor:	Air Force Wright Aeronautical Laboratories
Objective:	To investigate the influence of the size, location, and distribution of micropores associated with insoluble carbides on rolling contact fatigue behavior of M-50 steel.

Summary: Microporosity, consisting of voids up to three microns in size, associated with insoluble carbides, has been observed in this research program. This microporosity was noted in the course of a study on the effect of thermomechanical processing on microstructure of such steels and is thought to arise in the original manufacture of the steel. Steels such as M-50 have a wide melting range and overheating prior to hot working, or adiabatic heating during such working, may result in partial melting and cavitation. Hence, the defect may not be present in all heats of the steel, but may affect an undetermined portion of heats of such a steel and may be a factor in the scatter of rolling contact fatigue data for this steel. Recent work has measured the size distribution of the micropores and found it to follow a log-normal distribution. Further work will examine crack initiation to evaluate the effect of the microporosity as well as the possibility of closing the porosity by hot isostatic pressing (HIP).

Publication: F. A. Butterfield and T. R. McNelley, "Porosity Associated with Insoluble Carbides in VIM-VAR AISI M-50 Steel and its Probable Effects on Rolling Contact Fatigue," Paper Number 85-Trib-39, Transactions of ASME, Journal of Tribology, forthcoming.

Conference Presentations: T. R. McNelley, "Observation of Microporosity in a Heat of M-50 Steel," Advances in Bearings Technology Seminar, Naval Postgraduate School, Monterey, California, August 21-22, 1985.

F. A. Butterfield and T. R. McNelley, "Porosity Associated with Insoluble Carbides IN VIM-VAR AISI M-50 Steel and its Probable Effects on Rolling Contact Fatigue," Paper Number 85-Trib-39, ASME/ASLE Joint Lubrication Conference, Atlanta, Georgia,

October 8-10, 1985.

Theses Directed: F. A. Butterfield, "Rolling Contact Fatigue Testing of Thermomechanically Processed M-50 Steel," Master's Thesis, December 1984.

N. H. Camerino, "Effect of Prior Warm Rolling on the Retained Austenite Content and Hardening Response of (VIM-VAR) AISI M-50 Steel," Master's Thesis, March 1985.

J. L. Perry, "The Character of Observed Porosity and its Probable Effect on Rolling Contact Fatigue Life of M-50 Steel," Master's Thesis, March 1985.

Title: Utilization of Stainless vs. Monel in Pressurized
                    Oxygen Systems

Investigators: T. R. McNelley, Associate Professor of Materials
                    Science and LCDR Bert Marsh, USN

Sponsor: Naval Sea Systems Command

Objective: To conduct a critical review of the literature con-
                    cerning ignition and combustion of stainless steel
                    and Monel in pressurized oxygen systems.

Summary: Discrepancies exist with regard to material require-
                    ments for the storage handling and mixing of pres-
                    surized oxygen gas. A critical review of the current
                    scientific understanding of the ignition and com-
                    bustion of stainless steel and monel was conducted.

Thesis Directed: B. Marsh, "The Use of Austenitic Stainless Steel
                    versus Monel (Ni-Cu) Alloy in Pressurized Gaseous
                    Oxygen (GOX) Life Support Systems," Master's Thesis,
                    March 1985.

Title: Jet Vane Thrust Vector Control System Heat Transfer
                    Modeling

Investigators: R. H. Nunn, Professor of Mechanical Engineering, and
                    M. D. Kelleher, Professor of Mechanical Engineering

Sponsor: Naval Weapons Center

Objective: To develop analytical models to predict the heat
                    transfer characteristics of jet vanes immersed in a
                    rocket nozzle exhaust and to conduct verification
                    experiments.

Summary: The project has been organized into an analytical
                    part and an experimental part. These parts are
                    closely coordinated and are intended to be mutually
                    complementary. This organizational structure is
                    merely to facilitate the assignment of tasks specif-
                    ically in the assignment of student thesis research
                    topics.

                    To carry out the analytical/numerical modeling por-
                    tion of the project the PHOENICS systems of programs
                    has been procured from CHAM, Ltd., of London.
                    PHOENICS is a computer code system capable of simula-
                    ting a large number of fluid-flow, heat transfer and
                    chemical reaction processes which arise in many engin-
                    eering situations. The version of PHOENICS which has
                    been acquired contains the option for using body
                    fitted coordinates as well as the graphics package
                    for this option. This will allow the complex geo-
                    metries associated with jet vanes in conical flow to
                    be handled. The code has been installed on the IBM
                    3033 computer at NPS. The experimental program is
                    developing capability to evaluate the results of the
                    numerical modeling (PHOENICS) studies. Having
                    established this capability, it is anticipated that
                    the use of an infrared thermal imaging video system
                    will allow the evaluation of heat transfer effects
                    in geometries that are too complex for simulation by
                    presently available numerical modeling packages. The
                    heat transfer from a heated double wedge (slender,
                    diamond shape) at zero angle of attack in a two-dim-
                    ensional, viscous, supersonic flow is the first
                    problem being investigated. Subsequently, the effect
                    of conical flow and angle of attack will be investi-
                    gated. Further studies are planned to investigate
                    the influence of boundary surfaces on the flow and
                    heat transfer over the wedge.

Title: Simulation and Synthesis of Electromechanical
                    Actuators

Investigators: R. H. Nunn, Professor of Mechanical Engineering, and
                    A. Gerba, Associate Professor of Electrical and Com-
                    puter Engineering

Sponsor: Naval Weapons Center

Objective: Development of simulation and design codes for elec-
                    tromechanical actuators. Work in support of Naval
                    Weapons Center program "Advanced Missile Control
                    Devices."

Publication: R. H. Nunn, and R. J. Wright, "Modeling and Simula-
                    tion of a Fin Actuation System," Naval Postgraduate
                    School Technical Report, NPS69-84-011, December 1984.

Thesis Directed: R. J. Wright, "Simulation and Synthesis of Electro-
                    Mechanical Actuators," Master's Thesis, September
                    1984.

Title:	Martensitic Transformation in Shape Memory Alloys
Investigator:	Jeff Perkins, Professor of Mechanical Engineering
Sponsor:	National Science Foundation
Objective:	To examine the effect of microstructural parameters such as parent phase grain size, dislocation density, etc., on martensitic transformation morphologies and shape memory behavior.

Summary: A good deal of progress has been made in the examination of martensitic microstructures after pre-deformation and cycling treatments. Effects on transformation kinetics have been considered in detail. Also, high resolution TEM techniques have been applied to study the fine structure of the martensitic microstructures.

Publications:

Kenji Adachi and Jeff Perkins, "Lattice Image Studies on the Intervariant Boundary Structure and Substructure of Cu-Zn-Al 18R Martensite," Metallurgical Transactions 16A, 1985, pp. 1551-66.

Kenji Adachi, Jeff Perkins and C.M. Wayman, "Crystallography and Boundary Structure of Interplate-group Combinations of 18R Martensite Variants in Cu-Zn-Al Alloys," Fall 1985 Meeting of the Japan Institute of Metals, Niigata University, Japan, Oct. 4-6, 1985.

Jeff Perkins and Paul Bobowiec, "Microstructural Effects of Martensitic Transformation Cycling of a Cu-Zn-Al Alloy: Vestigial Structures in the Parent Phase," Metallurgical Transactions 17A, 1985, pp. 195-204.

Jeff Perkins, "Shape Memory Alloys," in Encyclopedia of Science and Technology, 6th edition, McGraw-Hill, New York.

Kenji Adachi, Steve Sullivan and Jeff Perkins, "Deformation of Martensite in a Polycrystalline Cu-Zn-Al Alloy," Metallurgical Transactions (In Press).

Kenji Adachi, Jeff Perkins and C.M. Wayman, "Type II Twins in Self-Accommodating Martensite Plate Variants in a Cu-Zn-Al Shape Memory Alloy," Acta Metallurgica (In Press).

Kenji Adachi, Jeff Perkins and C.M. Wayman, "The Crystallography and Boundary Structure of Inter-Plate-Group Combinations of 18R Martensite Variants in Cu-Zn-Al Shape Memory Alloys," Acta Metallurgica (In Press).

Kenji Adachi and Jeff Perkins, "The Effect of Thermal Cycling on the Parent and Martensite Microstructures in Cu-Zn-Al Shape Memory Alloys," Acta Metallurgica (In Press).

Title:	Analytic Model of Gas Turbine Engine Installations
Investigator:	P. F. Pucci, Professor of Mechanical Engineering
Sponsor:	Naval Sea Systems Command
Objective:	To further develop an analytic model for the install-ation of a gas turbine engine aboard a naval ship.
Summary:	The analytic computer simulation of a marine gas turbine engine installation, including its intake and exhaust ducting, previously developed by S. M. Ezzell, (M.S.M.E. Thesis, March 1984), was improved. The program was used to predict the performance of the four inlet-exhaust systems of a proposed destroyer.
Thesis Directed:	Y. Yucesoy, "Gas Turbine Propulsion Engine Perform-ance Prediction," Master's Thesis, September 1985

Title: Exhaust Gas Eductor Design

Investigator: P. F. Pucci, Professor of Mechanical Engineering

Sponsor: Naval Sea Systems Command

Objective: To assist NAVSEA in the design of Exhaust Gas
                    Eductor Systems.

Summary: Four models of two proposed designs, one pair for
                    the hot test facility and one pair for the cold flow
                    test facility were delivered by an outside contrac-
                    tor to Naval Postgraduate School and were tested.
                    The results of the tests were reported to NAVSEA
                    in Theses.

Theses Directed: R. A. Klocek, "Cold Flow Performance of a Four
                    Nozzle Gas Eductor System With a Shrouded Mixing
                    Stack," Master's Thesis, June 1985.

                    O. G. Reimann, "Hot Flow Performance of a Four
                    Nozzle Gas Eductor System With a Shrouded Mixing
                    Stack," Master's Thesis, September 1985.

Title: Gas Turbine Propulsion Engine Installation

Investigator: P. F. Pucci, Professor of Mechanical Engineering

Sponsor: Naval Sea Systems Command

Objective: To assist NAVSEA in the model testing of a proposed
                gas turbine propulsion engine installation.

Summary: Contracted with General Electric Company and the
                Aeronautical Research Laboratory of the Ohio State
                University for the fabrication, instrumentation,
                testing and the reporting of results of the inlet
                and exhaust systems for the gas turbine propulsion
                engines of a proposed destroyer. Investigator
                visited test site (OSU) to witness tests and attend-
                ed contractor briefing of results to NAVSEA in Wash-
                ington, D.C.

Title: Three-Dimensional, Primitive-Variable Modeling of
                    Flows Within Gas Turbine Test Cells

Investigator: D. Salinas, Associate Professor of Mechanical Engin-
                    eering

Sponsor: Naval Surface Weapons Center

Objective: To adapt the Garrett 3-D combustor code to the test
                    cell geometry and flow environment of jet engine
                    test cells; and to use the code to predict the tem-
                    perature, pressure, and velocity profiles within an
                    augmentor tube.

Summary: It is important in the initial design, as well as in
                    any subsequent modifications, of test cells to be able
                    to predict the flow environment within augmentor
                    tubes. Past efforts have only been partially success-
                    ful since they have been obtained using one or two-
                    dimensional models. The flows are most often three-
                    dimensional due to secondary air injection and/or the
                    placement of pollution/noise abatement devices. These
                    devices also affect the velocity and temperature dis-
                    tributions at the exit of the exhaust stack. This
                    can have significant effects on the required posi-
                    tioning of pollution/measurement devices.

Conference   D. Salinas, "Three-Dimensional, Primitive-Variable
Presentation: Modeling of Flows Within Gas Turbine Test Cells,"
                    DoD Workshop on Jet Engine Test Facilities, Jackson-
                    ville, Florida, October 21-23, 1985.

Title: Vortex Induced Disturbances on Fluid Interfaces

Investigator: T. Sarpkaya, Distinguished Professor of Mechanical
                    Engineering

Sponsor: Chief of Naval Research

Objective: To carry out both theoretical and experimental
                    studies to determine the fluid-mechanical mechanisms
                    which govern the rise and demise of vortices and
                    the inception of interfacial disturbances in homo-
                    geneous and density-stratified media.

Summary: Numerous experiments were carried out in a long and
                    rather unique towing tank facility with various lift-
                    ing surfaces moving at specified angles of attack in
                    a homogeneous and a density-stratified medium. The
                    characteristics of the resulting vortices, vortex
                    rings, surface scars, striations, and ring disturb-
                    ances have been evaluated in terms of the governing
                    parameters. In addition, a theoretical analysis has
                    been carried out and a computer code has been devel-
                    oped to predict the characteristics of the surface
                    disturbances. The results have shown excellent
                    agreement with those obtained experimentally and led
                    to the discovery of the circulation decay law.

Publications: T. Sarpkaya, "Surface Signatures of Trailing Vor-
                    tices," Journal of Fluid Mechanics, 1985, forthcoming.

                    T. Sarpkaya, "Surface Signature of Trailing Vortices,"
                    in Proceedings of the International Conference on
                    Vortical Flows in Aerodynamics, Aachen, February
                    1985.

Theses Directed: W. E. Gray, "Scars and Striations Due to Trailing
                    Vortices," Master's and Engineer's Thesis, March
                    1985.

                    K. G. Heffernan, "Trailing Vortex Attenuation
                    Devices," Dual Masters' Thesis, June 1985.

                    D. S. Shikada, "Vortex Rings and Surface Signatures,"
                    Master's and Engineer's Thesis, September 1985.

Title:	Yaw and Current Effects on Hydrodynamic Resistance of Cylinders in Harmonic Flow
Investigator:	T. Sarpkaya, Distinguished Professor of Mechanical Engineering
Sponsor:	National Science Foundation
Objective:	To carry out fundamental studies regarding the hydrodynamic resistance of smooth and rough cyliners immersed in time-dependent flows.

Summary: Extensive analysis and experiments have been carried out to understand the fundamental mechanisms governing the hydrodynamic resistance in unsteady flows. Analysis is based on the use of the discrete vortex model and the representation of the body by distributed singularities. Experiments have been carried out in a unique U-shaped oscillating flow tunnel. The impulsively-strated flow experiments were carried out in a 25-feet high vertical water tunnel. The results have been reported in various publications.

Publications: T. Sarpkaya, "Force on a Circular Cylinder in Viscous Oscillatory Flow at Low Keulegan-Carpenter Numbers," Journal of Fluid Mechanics, 1985.

T. Sarpkaya and C. J. Ihrig, "Impulsively-Started Flow About Rectangular Prisms: Experiments and Discrete Vortex Analysis," Journal of Fluids Engineering of ASME, 1985.

T. Sarpkaya, "Past Progress and Outstanding Problems in Time-Dependent Flows About Ocean Structures," in Proceedings of the International Conference on Separated Flow About Marine Structures, pp.1-36, Norwegian Institute of Technology, Trondheim, Vol. 1.

T. Sarpkaya, "Analysis of Separated Time-Dependent Flow About Bluff Bodies Through the Use of the Discrete Vortex Model," First International Conference on High Reynolds Number Flow Computation, Nobeyama, Japan, Springer-Verlag, 1985.

T. Sarpkaya and J. C. Heideman, "Hydrodynamic Forces on Dense Arrays of Cylinders," in Offshore Technology Conference Proceedings, Paper No. OTC-5008, Vol. 1, pp.421-428, May 1985.

L. C. Janikowsky and T. Sarpkaya, "Optimized Discrete Singularity Representation of Axisymmetric Bodies," AIAA Paper No. AIAA-85-0284, January 1985.

T. Sarpkaya, "A Critical Assessment of the Methods of Analysis of Offshore Structures," in Proceedings of the International Conference on Wave Flows in Hydrodynamics, Hannover, West Germany, Springer-Verlag, June 1985.

T. Sarpkaya, "On Fluid Loading of Offshore Structures: After Ten Years of Basic and Applied Research," ASME Energy Technology Conference (Proceedings of), New Orleans, Louisiana, February 1985.

Theses Directed: N. Yuen, "Oscillatory Flow About Cylinders at Low Keulegan-Carpenter Numbers," Master's and Engineer's Thesis, September 1985.

Title: Post-processing of STAGS-2000 Code Using Color
                    Graphics System

Investigator: Y. S. Shin, Associate Professor of Mechanical Engin-
                    eering

Sponsor: David W. Taylor Naval Ship Research & Development
                    Center

Objective: To develop the interface program between STAGS-2000
                    computer code and PATRAN color graphics system.

Summary: STAGS-2000 code is the computer program to calculate
                    the non-linear stiffened shell responses of submarine
                    hull developed by Lockheed Research Laboratory under
                    the sponsorship of David Taylor Naval Ship Research
                    & Development Center. The interface computer program
                    was developed to post-process the STAGS-2000 results
                    using PATRAN 3-D color graphics system.

357

Title: Studies on Material Damping Characteristics of Copper
                  Alloy

Investigator: Y. S. Shin, Associate Professor of Mechanical Engin-
                  eering

Sponsor: David W. Taylor Naval Ship Research and Development
                  Center

Objective: To determine the damping characteristics of the
                  copper alloys including 99.95% pure copper, a com-
                  posite containing 25 volume % aluminum oxide parti-
                  cles in a Cu-8Al matrix, a composite containing 25%
                  Boron carbide particles in Cu-8Al matrix, and pure
                  copper.

Summary: The loss factors of all four specimens were deter-
                  mined. The results showed that 99.95% Copper
                  appears to have more damping in low frequency range,
                  1.7% loss factor. In higher frequency range, all
                  four materials showed quite low damping (¼0.5% loss
                  factor).

Title: Underwater Shock Response of Submerged Structure

Investigator: Y. S. Shin, Associate Professor of Mechanical Engin-
                    eering

Sponsor: Defense Nuclear Agency

Objective: (1) To look into the insight of the stiffener trip-
                    ping characteristics and its effect on gross shell
                    responses; (2) to perform underwater explosion test-
                    ing using stiffened plates for stiffener tripping
                    and to compare the numerical analysis results with
                    that of the experiment, and (3) to evaluate the sub-
                    marine-installed equipment response to underwater
                    explosion.

Summary: Experimental investigation into the responses of air
                    backed, externally-stiffened flat plates has been
                    conducted. A series of three underwater explosion
                    (UNDEX) tests were performed. It was difficult to
                    make stiffener tripping using flat stiffened plate.
                    However, this is the simplest model that can be con-
                    trolled well to acquire clean stiffener tripping test
                    data without the complication of all other side
                    effects. The rectangular stiffener was used. First,
                    non-linear static test was performed by increasing
                    hydro-static pressure to observe stiffener tripping.
                    The stiffened plate was securely mounted on the air-
                    backed backing structure and air pocket was pressur-
                    ized in step. The clear stiffener tripping was
                    observed. Using the same geometry, the UNDEX tests
                    were performed using 8 pound TNT charge and 10 feet
                    standoff distance. The stiffener tripping was suc-
                    cessful.

                    The ring-stiffened circular cylindrical shell con-
                    taining the simulated internal equipment is submerged
                    in an infinite expanse of water and is subjected to
                    (1) end-on loading and (2) side-on loading from an
                    underwater explosion. A parametric study has been
                    performed (1) to determine how heavy the internal
                    equipment must be before it affects the motion of
                    the shell, and (2) to evaluate the dynamic amplifica-
                    tion of the response of the internal equipment which
                    should occur when the motion of the shell has a
                    frequency about equal to a fixed-base frequency of
                    the internal equipment.

Publications: T. R. Rentz and Y. S. Shin, "On the Field Experiences

359

of UNDEX Testing for a Stiffened Flat Plate Model," Shock and Vibration Bulletin 55, Part II, June 1985, pp173-190.

I.-B. Joung and Y. S. Shin, "A New Model on Transient Wave Propagation in Fluid-Filled Tubes," ASME Journal of Pressure Vessel and Piping Technology, forthcoming.

Conference Presentations:

T. R. Rentz and Y. S. Shin, "On the Field Experiences of UNDEX Testing for a Stiffened Flat Plate Model," 55th Shock and Vibration Symposium, Dayton, Ohio, October, 1984.

M. S. Welch and Y. S. Shin, "Numerical Analysis of the Underwater Shock-induced Responses of Submarine Installed Equipment," 55th Shock and Vibration Symposium, Dayton, Ohio, October, 1984.

I.-B. Joung and Y. S. Shin, "A New Model on Transient Wave Propagation in Fluid-Filled Tubes," ASME Pressure Vessel and Piping Conference, New Orleans, Louisiana, June, 1985.

Theses Directed:

N. R. King, "Underwater Shock-Induced Responses of Stiffened Flat Plates: An Investigation into The Predictive Capabilities of the USA-STAGS Code," Master's Thesis, December 1984.

J. H. Strandquist, "Investigation into the Effects of Using Detonating Cord to Remove a Conventional Propeller from a Waterborne Surface Ship," Master's Thesis, December 1984.

J. R. Langan, "Investigation into the Comparisons of the Underwater Shock Effects on a Stiffened Flat Plate to the Predictive Nature of a Computer Model," Master's Thesis, March 1985.

Title: Vibration Damping Measurement and Modal Testing Conducted at Low Stress Level and High Frequency Range with Wide Temperature Variation

Investigator: Y. S. Shin, Associate Professor of Mechanical Engineering

Sponsor: David W. Taylor Naval Ship Research & Development Center

Objective: To design a test procedure and to perform modal testing to measure the damping of the plate specimen at low stress level and high frequency range with temperature variations: (a) plate specimen of 40"x14"x 1" and 40"x14"x2", or proportionally reduced sizes; (b) frequency range of 100 Hz through 15,000 Hz; (c) temperature range of $-5^\circ C$ through $25^\circ C$, and (d) air and water environments.

Summary: The damping characteristics of constrained layered plates were investigated as a function of temperature, frequency, and exciter-sensor orientation. Two different constrained layered plates were tested and the results were compared. Each has a one inch thick aluminum base plate, and a one-eighth inch brass constraining layer. For one specimen, the viscoelastic layer was a one-sixteenth inch butyl 1066 rubber while the other was a rubber called Deadbeat, of the same thickness. The test results were compared with predicted results based on the fourth order beam theory over the frequency range of 100 Hz to 25 KHz, and a temperature range of 0 to $30^\circ C$.

The feasibility of using small homogeneous specimens to determine the damping characteristics was also investigated because of the size limitation of specimen in the process of developing high damping alloy. The small specimens are cast nickel bronze. The sizes are 2"x2"x1/16", 3"x3"x1/16", and 4"x4"x1/16". The measured damping results were compared with that of large plate with the same material.

Publications: Y. S. Shin and K. D. Schulze, "Investigation of Damping Characteristics of Composite Plate and Small Homogeneous Specimens - Progress Report," Naval Postgraduate School Technical Report, NPS69-85-001, March 1985.

Y. S. Shin and K. D. Schulze, "Investigation of Damping Characteristics of Constrained Layered Plates

and Small Homogeneous Specimens - Progress Report," Naval Postgraduate School Technical Report, NPS69-85-005, September 1985.

Theses Directed: P. F. Milster, "Effect of Temperature and Environmental Changes on the Damping Properties of Randomly Excited Metal Specimens," Engineer's Thesis, December 1984.

K. D. Schulze, "Investigation of Damping Characteristics of Constrained Layered Plates and Small Homogeneous Specimens," Engineer's Thesis, September 1985.

Title: Optimal Control of Robotic Mechanisms

Investigator: D. L. Smith, Associate Professor of Mechanical Engin-
                    eering

Sponsor: NPS Foundation Research Program

Objective: To investigate the application of optimal control
                    theory to the control of robotic mechanisms.

Summary: Computer-based controllers operating optimal control
                    algorithms are capable of coordinating robotic
                    motions in complex mechanisms. This work is aimed at
                    identifying the research issues surrounding this type
                    of control.

                    A table-top manipulator arm and a programmable con-
                    troller were selected and purchased. A data acqui-
                    sition system has been designed and is being
                    installed. A nonlinear simulation of the arm, the
                    hydraulics, and the rudimentary built-in controller
                    has been developed. Test cases have been identified
                    to validate simulations and optimal control logic.

Theses Directed: D. Lewis, "Modeling of Low-Speed Motion of Rigid,
                    Revolute Mechanisms," Master's Thesis, December 1985.

                    W. McCarthy, "Simulation of High-Speed Motion of
                    Rigid, Revolute Mechanisms," Master's Thesis, Dec-
                    ember 1985.

INVESTIGATOR INDEX

367

DISTRIBUTION LIST

Defense Technical Information Center   2
Cameron Station
Alexandria, VA   22314

Library of Congress, Unit X   1
Documents Expediting Project
    Exchange and Gift Division
Washington, DC   20540

Office of the Under Secretary of Defense   1
    for Research and Engineering
The Pentagon
Room 3E1006
Washington, DC   20301

Office of the Director Net Assessment   1
The Pentagon
Room 3A930
Washington, DC   20301

Director Accession Policy   1
(Manpower Installations & Logistics)
The Pentagon
Room 2B269
Washington, DC   20301

Deputy Under Secretary of Defense   1
(Research and Advanced Technology)
The Pentagon - Room 4D745
Washington, DC   20350

Central Intelligence Agency   1
OCR/LDSD/DB/Standard Dist.
GE47 HQ
Washington, DC   20505

Defense Advanced Research Projects Agency   1
Arlington, VA   22209

Defense Communications Agency   1
National Military Command Systems
    Support Center
Washington, DC   20301

Defense Nuclear Agency   1
ATTN: STTI
Washington, DC   20305

National Aeronautics and Space   1
    Administration
Moffett Field, CA   94035

National Aeronautics and Space   1
    Administration
Washington, DC   20546

National Security Agency   1
ATTN: R621
Fort Meade, MD   20755

```
Secretary of the Navy                                    1
The Pentagon - Room 4E686
Washington, DC  20350

Assistant Secretary of the Navy                          1
(Manpower & Reserve Affairs)
The Pentagon - Room 4E788
Washington, DC  20350

Assistant Secretary of the Navy                          1
(Research Engineering and Systems)
The Pentagon - Room 4E736
Washington, DC  20350

Principal Deputy Assistant Secretary                     1
   of the Navy
(Manpower Installations & Logistics)
The Pentagon
Room 3E308
Washington, DC  20301

Deputy Assistant Secretary of the Navy                   1
(Manpower Installations & Logistics)
The Pentagon
Room 3C963
Washington, DC  20301

Deputy Assistant Secretary of the Navy                   1
(Force Management and Personnel)
The Pentagon - Room 4E789
Washington, DC  20350

Chief of Naval Operations
Washington, DC  20350

   Code OP-06                                            1
   Code OP-11                                            1
   Code OP-15                                            1
   Code OP-91                                            1
   Code OP-006                                           1
   Code OP-009                                           1
   Code OP-094                                           1
   Code OP-095                                           1
   Code OP-941                                           1
   Code OP-942                                           1
   Code OP-943                                           1
   Code OP-944                                           1
   Code OP-951                                           1

Naval Air Systems Command                                1
Air 54113B
Jefferson Plaza
Washington, DC  20361

Naval Air Systems Command                                1
APC205-0
Washington, DC  20361-1205

Naval Air Systems Command                                1
Technical Director
Research and Technology (AIR-03A)
Washington, DC  20361
```

Space and Naval Warfare Systems Command
Washington, DC 22182

Code PDW-106	1
Code PDW-107	1
Code PDW-108	1
Code PDW-108-4	1

Naval Sea Systems Command   1
Washington, DC 20362-5101

Code 06	1
Code 05	1
Code 003	1
Code SEA 09831	1

Naval Supply Systems Command   1
Washington, DC 20376

Chief of Naval Research
800 North Quincy St.
Arlington, VA 22217-5000

Code 100	1
Code 102	1
Code 102B	1
Code 114	1
Code 400	1
Code 410	1
Code 413	1
Code 420	1
Code 1114	1

Office of Naval Research   1
Western Regional Office
1030 East Green St.,
Pasadena, CA 91106'

Librarian   1
Office of Naval Research, London
Box 39
FPO New York 09510-0700

Naval Air Development Center   1
Street Road
Warminster, PA 18974

Naval Air Propulsion Test Center   1
Trenton, NJ 08628

Naval Coastal Systems Center   1
Panama City, FL 32407

NPRDC   1
Pensacola Support Office
Code 00A3
Chief of Naval Education and Training
NAS, Pensacola, FL 32508

Naval Environmental Prediction Research   1
    Facility
Monterey, CA 93943

Naval Personnel Research and Development Center San Diego, CA 92152	1
Naval Ocean Systems Center ATTN: Technical Library Code 9642B San Diego, CA 92152-5000	1
David W. Taylor Naval Ship Research & Development Center Bethesda, MD 20084	1
David W. Taylor Naval Ship Research & Development Center Code 012-3 Bethesda, MD 20084	1
Naval Surface Weapons Center Dahlgren, VA 22448	1
Naval Surface Weapons Center Silver Spring, MD 20910	1
Naval Underwater Systems Center ATTN: Technical Library, 02152 Newport, RI 02841-5047	1
Naval Weapons Center Code 01 China Lake, CA 93555-6001	1
Naval Weapons Center ATTN: Technical Library Code 3431 China Lake, CA 93555-6001	1
Naval Weapons Center Code 3205 China Lake, CA 93555-6001	1
Naval Research Laboratory Washington, DC 20375	1
Naval Weapons Laboratory Dahlgren, VA 22448	1
Naval Civil Engineering Lab ATTN: Library - Code L08A Port Hueneme, CA 93043-5003	1
Dr. J.E. Andrews Naval Ocean Research and Development Activity NSTL, MS 39529-5004	1
Mr. William H. Lindahl Naval Training Systems Center Orlando, FL 32813	1
Documents Library New London Lab Naval Underwater Systems Center New London, CT 06320	1

Naval Surface Weapons Center   1
P20
White Oak
Silver Spring, MD   20903-5090

Naval Undersea Warfare Engineering   1
    Station (Code 80)
Keyport, WA   98345-0580

Joint Cruise Missiles Project   1
JCM-211
Washington, DC   20360

Naval Air Station   1
Pensacola, FL   32508

Naval Air Rework Facility   1
Naval Air Station, North Island
San Diego, CA   92135

Naval Safety Center   1
Naval Air Station
Norfolk, VA   23511

Naval Air Test Center   1
Patuxent River, MD   20670

Naval Amphibious Group Eastern Pacific   1
Naval Station Box 201
San Diego, CA   92136

Center for Naval Analyses   1
ATTN: Acquisitions Unit Documentation
4401 Ford Ave.
Alexandria, VA   22302-0268

Naval Data Automation Command   1
ATTN: Executive Assistant
Department of the Navy
Washington, DC   20374

Navy Department Library   1
Building 44
Washington Navy Yard
Washington, DC   20374-0571

Chief of Naval Education and Training   1
Code N-02
Naval Air Station
Pensacola, FL   32508

Naval Facilities Engineering Command   1
200 Stoval St.
Alexandria, VA   22332

Naval Facilities Engineering Command   1
Western Division
P.O. Box 727
San Bruno, CA   94066

Fleet Combat Direction Systems   1
    Support Activity
San Diego, CA   92147

Navy Fleet Material Support Office   1
Mechanicsburg, PA   17055

Fleet Numerical Oceanography Center   1
Monterey, CA   93943-5005

Naval Intelligence Support   1
4301 Suitland Road
Washington, DC   20390

Oceanographer of the Navy   1
Naval Observatory
Washington, DC   20390

Naval Oceanographic Office   1
Washington, DC   20373

Naval Ocean R&D Activity   1
ATTN: Code 125L/Library
NSTL, MS   39529-5004

Naval Oceanographic Systems   1
P.O. Box 1390
Pearl Harbor, HI   96860

Naval Ship Systems Engineering Station   1
Philadelphia, PA   19112

Naval Undersea Warfare Engineering   1
   Station - Code 70
Keyport, WA   98345-0580

Naval Weapons Station   1
Seal Beach, CA   90740

Strategic Systems Project Office   1
Washington, DC   20376

Commandant of the Marine Corps   1
(HQSP-2)
Washington, DC   20380

U.S. Marine Corps Development and   1
   Education Command
Quantico, VA   22134

Base Education Office   1
ATTN: MSgt Hakim
Marine Corps Logistics Base
Albany, GA   31705

U.S. Army Air Defense School   1
ATTN: ATSA-CDT-S
Fort Bliss, TX   79916-7050

U.S. Army Communications Electronics   1
   Engineering Installation Agency
Fort Huachuca,   AZ   85613

U.S. Army Defense Ammunition Center   1
   & School Evaluation Division
ATTN: SARAC-DEV, McIntosh
Savanna, IL   61074

U.S. Army Electronic Proving Ground Fort Huachuca, AZ 40121	1
U.S. Army Foreign Sciences Technology Center 220 7th Street N.E. Charlottesville, VA 22901	1
U.S. Army Military Enlistment Procurement Command Fort Sheridan, IL 60037	1
U.S. Army Missile Command Redstone Scientific Information Center ATTN: AMSMI-RD-CS-R/Documents Redstone Arsenal, AL 35898-5241	1
U.S. Army Research Office Triangle Park, NC 27709	1
U.S. Army Training & Doctrine Command Fort Monroe, VA 23651	1
U.S. Army Troop Support Command St. Louis, MO 63120	1
U.S. Army War College ATTN: Library Carlisle Barracks, PA 17013-5050	1
U.S. Military Academy West Point, NY 10996	1
U.S. Army Ballistic Research Laboratory U.S. Army Armament Research and Development Command Aberdeen Proving Ground, MD 21005	1
Director U.S. Army Night Vision and Electro- Optics Lab ATTN: Code DEL NV-VI Fort Belvoir, VA 22060	1
Librarian ATTN: Marina Grinera Post Library Bldg. 31 Fort Benjamin Harrison, IN 46216-5100	1
Technical Support Center Engineering Division Kelly Air Force Base, TX 78241	1
Air Force Staff College Wright-Patterson AFB, OH 45433	1
AFHRL/LRS TDC ATTN: Susan Stiller Wright-Patterson AFB, OH 45433	1
AFWAL Technical Library AFWAL/GLISL Wright-Patterson AFB, OH 45433	1

Air Force Rocket Propulsion Laboratory   1
Technical Library STOP 24
Edwards AFB, CA 93523-5000

Air Force Weapons Laboratory   1
Kirtland Air Force Base
Albuquerque, NM 87117

Headquarters   1
Space Division, CRP-MIPR Control
P.O. Box 92960
Worldway Postal Center
Los Angeles, CA 90009

U.S. Coast Guard Academy   1
New London, CT 06320

Energy Research and Development   1
   Administration
Washington, DC 20545

National Environmental Satellite Service   1
Department of Commerce
Rockville, MD 20852

National Oceanic and Atmospheric   1
   Administration
Washington, DC 20233

National Science Foundation   1
Washington, DC 20550

Officer-in-Charge   1
Dept. of Naval Science
Calhoon MEBA, Engineering School
c/o Naval Research Center
Fort McHenry
Baltimore, MD 21230

Officer-in-Charge   1
Dept. of Naval Science
California Maritime Academy
P.O. Box 1392
Vallejo, CA 94590

Officer-in-Charge   1
Dept. of Naval Science
Massachusetts Maritime Academy
State Pier
Buzzards Bay, MA 02532

Officer-in-Charge   1
Personnel Support Activity Detachment
Bremerton, WA 98314-5305

Naval Telecommunications Command   1
4401 Massachusetts Ave.
Washington, DC 20390

Pacific Missile Test Center   1
Point Mugu, CA 93042

Naval Postgraduate School   No. of Copies
Monterey, CA 93943

Superintendent	1
Provost	1
Director of Programs, Code 03	1
Director Mil. Ops., Code 04	1
Dean of Information & Policy Sciences, Code 05	1
Dean of Science and Engineering, Code 06	1
Dean of Educational Development, Code 011	1
Director, Research Administration, Code 012	25
Director of Academic Planning, Code 013	1
Dean of Academic Administration, Code 014	1
Library	2

Department of:

Chair, Com. Sci, Code 52	1
Chair, Math, Code 53	1
Chair, Admin. Sci, Code 54	1
Chair, Ops. Res, Code 55	1
Chair, NSA, Code 56	1
Chair, Physics, Code 61	1
Chair, Elec. and Comp. Eng, Code 62	1
Chair, Meteor., Code 63	1
Executive Director, Defense Resources Management Education Center, Code 64	1
Chair, Aeron., Code 67	1
Chair, Ocean., Code 68	1
Chair, Mechanical Engineering, Code 69	1

ASW Academic Group, Code 71	1
Space Systems Academic Group, Code 72	1
EW Academic Group, Code 73	1
Command, Control & Communications Group, Code 74	1

Curricular Officer of:

Operations Research/Systems Analysis, Code 30	1
Aeronautical Engineering, Code 31	1
Electronics & Communications, Code 32	1
Weapons Engineering & Antisub Warfare, Code 33	1
Naval Engineering, Code 34	1
Air-Ocean Sciences, Code 35	1
Administrative Sciences Programs, Code 36	1

END

1-87

DTIC